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ABSTRACT

***Background*: The anthropometric parameters of the umbilical cord have clinical significance. Current parameters of the cord, its correlates and related foetal outcome are lacking in our parturients.**
***Objectives*: To describe the anthropometric parameters and abnormalities of the umbilical cord; and determine their maternal correlates and foetal outcome.**
***Design*: A cross sectional analytical study.**
***Setting*: The Obstetric and Gynaecology Department of the University of Ilorin Teaching Hospital, between September 2012 and June 2013.**
***Subjects*: Healthy pregnant women with singleton pregnancies.**
***Results*: Four hundred and twenty- eight (428) singleton deliveries were studied. The respective mean values of the cord length and width were526.87±115.5mm and 19.56±11.12mm.Short cord (< 40cm) occurred in 7.2% while long cord (> 69cm) was found in9.3% of the parturient. The incidences of single umbilical artery, cord round the body and knots were 7%, 8.4% and 14.5% respectively. Nuchal cord was the most common (91.4%). Only gestational age had significant statistical relationship with cord length abnormalities (P = 0.0093). The cord length was an important correlate of cord helices, knots and vessels (P< 0.05).Parity had correlations with the number of vessels(R= 0.099, P=0.042).**
The cord coiling index was statistically related to the presence of congenital abnormalities (P=0.011). Other perinatal events were not related to umbilical cord parameters. Perinatal asphyxia was the most common indication for NICU admission (3.5%) but there was no significant statistical difference between NICU admission and cord parameters.
***Conclusion*: The umbilical cord parameters in apparently healthy parturients in Ilorin were comparable with others elsewhere. The cord length and helix are important correlates of gestational age and congenital abnormalities. Parity may be related to abnormal umbilical vessels. Cord length,coils, coil index and umbilical vessels should be examined post-natally.**

INTRODUCTION

The umbilical cord, also called the "the birth cord", is the connection between the developing foetus and the placenta (1). It normally contains three vessels, two arteries and one vein surrounded by a connective tissue known "Wharton's jelly". Physiologically, the umbilical vein carries oxygenated blood to the foetus and the umbilical artery carries de-oxygenated blood to the mother from the foetus (1,2).

The anthropometric parameters of the umbilical cord such as length, width, number of vessels and coils (helices), have been linked with clinical significance in various reports. An earlier study in Nigeria, found a correlation between cord lengths, infant and placental weight (3). An Indonesian study found a linear correlation between umbilical cord length and perinatal asphyxia and cord entanglement (4). Also, authors have varying definitions of the mean values for these parameters based on the study

population and therefore, different definitions of its abnormalities.

Abnormalities of the umbilical cord range from single umbilical artery, short cord, velamentous insertion to true knots.Knots often result from the foetus as a whole or in parts, passing through a loop of the cord *in utero*. These abnormalities have been associated with congenital anomalies and adverse perinatal outcome. True knot was associated with advanced maternal age, multiparity, previous miscarriages, obesity, prolonged gravidity, male foetus, long cord, and maternal anaemia in a retrospective review of singleton pregnancies (5).

Past studies in our environment have documented various anthropometric parameters of the umbilical cord and their correlates (3,6). These studies were retrospective and perhaps the utilisation of modern antenatal services by our women may have influence on these parameters. Hence, recent trends in perinatal outcome relative to such measurements are important.

To the best of our knowledge, this is the first study on the characteristics and abnormalities of the umbilical cord and their outcome in Ilorin. Early identification of such abnormalities and their correlates could hasten measures needed to improve neonatal survival. An observed abnormality found at postnatal examination of the umbilical cord may have significant maternal or foetal correlates. This will form a basis for antenatal screening for this abnormality which may help predict foetal outcome.

The umbilical cord can easily be assessed with real-time ultrasound and its blood flow by the Doppler ultrasound, thereby assessing its functionality and morphology. This may give more information on the placenta and foetal well being (7,8). Unfortunately, most abnormalities are incidental findings and not routine contents of obstetric scans (9).

In addition, with recent advances in the ultrasound imaging techniques, sonographic evidences of these abnormalities may need to be demonstrated based on postnatal features and correlated with earlier examinations of affected foetuses.

This study describes the anthropometric parameters of the umbilical cord at delivery, cord abnormalities and their correlates among parturient in the University of Ilorin Teaching Hospital, Ilorin Nigeria. It is hoped that findings from this study will corroborate the need for prenatal ultrasound evaluation of the umbilical cord in pregnancies at risks of unfavourable outcome.

MATERIALS AND METHODS

This was a cross sectional, analytical study conducted in the Department of Obstetrics and Gynaecology, University of Ilorin Teaching Hospital, (U.I.T.H), Ilorin. Pregnant women who presented for delivery in the labour ward were randomly selected based on the inclusion criteria. Apparently healthy pregnant women at 28 weeks gestation or more with singleton pregnancies were included while multiple pregnancies were excluded.

Patients who met the criteria for this study were informed and counseled and ethical approval was obtained from the Research and Ethics Committee of the University of Ilorin Teaching Hospital.

Socio-demographic characteristics, relevant history of past and index pregnancies were noted. Immediately after delivery, the umbilical cord was clamped at the foetal end and cut with a sterile scissors taking care not to milk the cord. At the foetal end, the cord was cut five centimeters from the foetal insertion. The remaining length of the cord from the cut end to the placental insertion was then measured in centimetres. Five centimeters was added to the length of the measured cord. Next, the number of coils/ helices of the entire cord were counted and a coil was taken as one complete 360-degree spiral course of the umbilical vessels. Other features such as vasculature, knotting, cord round the neck, thickness of the umbilical cord, width and circumference were examined.

The degree of the umbilical cord coiling was determined by the umbilical coiling index (UCI), defined as the number of complete coils/helices per centimeter length of cord (10). The percentiles of the umbilical measurements were calculated and values less than 10^{th} centile were taken as low, values greater than 90^{th} centile as high and values between 10^{th} and 90^{th} centiles as normal. The gross examination was done within five minutes of delivery of the placenta in the second stage room.

The foetal outcomes were assessed by APGAR scores, birth weight, admission to neonatal intensive care unit (NICU), presence of congenital abnormalities and indications for admission.

RESULTS

A total of four hundred and twenty eight (428) singleton deliveries were studied. The mean values, ranges, percentiles of the umbilical cord parameters of the babies. Table1.

Table 1
Anthropometric parameters of the postpartum umbilical cord in the study population

Variable	Mean ± SD	Range	Percentiles				
			5th	10th	50th	90th	95th
Umbilical cord length (mm)	526.87 ± 115.15	101.00–1010.00	360.00	400.00	520.00	690.00	720.00
Umbilical cord width (mm)	19.56 ± 11.12	4.00 – 200.00	10.00	10.00	20.00	26.4	30.00
Number of Helices	10.86 ± 5.12	2 – 46	5.00	6.00	10.00	16.00	20.00
Number of knots	3.24 ± 5.49	1 – 25	1.00	1.00	1.00	10.70	20.95
Number of Artery	1.93 ± 0.26	1 – 2	1	2.00	2.00	2.00	2.00
Number of Veins	1.07 ± 0.26	1 – 2	1	1.00	1.00	1.00	2.00
Umbilical cord circumference(mm)	4.73 ± 5.75	0.4 – 61.00	1.81	2.00	4.00	6.00	6.00
Umbilical cord coil index	0.02 ± 0.01	0.00 – 0.10	0.0097	0.0125	0.0195	0.0308	0.0370

Maternal age ranged between 17 and 49 years with an average of 29.24 years ± 4.92 and parity was from 0-9 with a mean value of 2.The gestational age at delivery was between 30 and 44 weeks and the mean birth weight was 3.14Kg.

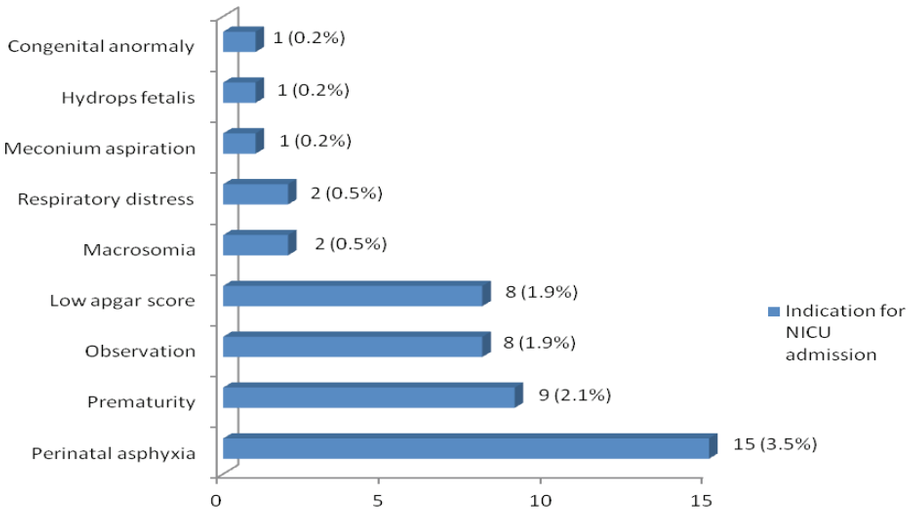
The pattern of foetal outcomes is displayed in Table 2. The most common indication for Neonatal Intensive Care Unit (NICU) admission among the babies was perinatal asphyxia in 3.5% of the study population. Other indications are shown in Figure 1.

Table 2
Pattern of foetal outcome of study population

Foetal Outcome GA at delivery(weeks)	
Mean ± SD	38.80 ± 1.95
Range	30 – 44
Birth weight(Kg)	
Mean ± SD	3.14 ± 0.44
Range	1.5 – 4.8
Apgar score at 1 minute	
Mean ± SD	6.49 ± 1.84
Range	0 – 9
Apgar score at 5 minutes	
Mean ± SD	8.00 ± 1.88
Range	0 – 10
Sex	
Male	223 (52.1%)
Female	205 (47.9%)
Congenital Anomaly	
Yes	7 (1.6%)
No	421 (98.4%)
Need for NICU admission	
Yes	47 (11.0%)
No	381 (89.0%)

SD- standard deviation

Figure 1
Indications for NICU admission



The umbilical parameters were compared with various foetal outcomes. There was no statistical relationship between the parameters and the need for NICU admission. Comparison with occurrence of congenital abnormalities is shown in Table 3 and there was a significant relationship between the mean umbilical coil index and the presence of congenital abnormalities among the babies (P= 0.011). The various congenital abnormalities seen were hydraencephaly, spina bifida, talipes, congenital hydrocele, achondroplasia, choanal atresia.

In addition, there was no statistical correlation between the umbilical cord parameters and perinatal events such as Apgar scores and birth weight.

Table 3
The comparison between the umbilical cord parameters and occurrence of congenital abnormalities.

Umbilical cord Parameter	Congenital abnormality		T	P-value
	Yes	No		
Umbilical cord length				
Mean ± SD	521.86 ± 96.21	527.10 ± 115.52	-0.324	0.746
Umbilical cord width				
Mean ± SD	15.43 ± 8.23	19.62 ± 11.16	-0.990	0.323
Number of helices				
Mean ± SD	15.14 ± 7.40	10.79 ± 5.05	2.241	0.021
Number of knots				
Mean ± SD	1.50 ± 0.71	3.30 ± 5.58	-0.453	0.652
Umbilical cord circumference				
Mean ± SD	3.60 ± 1.31	4.74 ± 5.80	-0.523	0.602
Umbilical coil index				
Mean ± SD	0.0305 ± 0.0154	0.0210 ± 0.0098	2.542	0.011*
Number of Artery				
Mean ± SD	1.86 ± 0.378	1.93 ± 0.254	-0.751	0.453
Number of Vein				
Mean ± SD	1.14 ± 0.38	1.07 ± 0.255	0.746	0.456

t – Independent samples T-test
SD – standard deviation
* P-value < 0.05

Table 4
Correlations between cord parameters, parity and gestational age

Umbilical cord Parameters	R	P-value
Parity		
Number of artery	-0.099	0.042*
Number of veins	0.099	0.042*
Gestational Age at Delivery		
Umbilical cord length	0.143	0.003*
Umbilical coil index	-0.097	0.048*

R – Correlation coefficient * - P value < 0.05

The significant correlations between cord length and coil index, and gestational age at delivery are shown in Table 4.There was positive correlation between number of veins and parity and a negative correlation between the number of arteries and parity. There was a positive correlation between apgar scores at 5th minute and maternal age (R = 0.161 P = 0.002) but no statistical correlation between other umbilical cord parameters and maternal age. The occurrence of congenital abnormalities was also not significantly related to maternal age and parity in this study (P =0.268, 0.799).

The cord winding around some parts of the body was found in 8.4% and the most common type was nuchal cord in 91.6% of the cases. The cord was inserted centrally in 67.8%,marginally in 31.3% and a velamentous insertion was observed in 0.9% of the study population. The umbilical cord abnormalities identified in this study are displayed in Table 5.

Table 5
Umbilical cord Abnormalities in the study population

Abnormalities	Value	N	Percentage (%)
Short cord	< 400 mm	31	7.2
Long cord	> 690 mm	40	9.3
Thin cord	< 10 mm	17	4.0
Thick cord	>25.4 mm	42	9.8
Single artery	≤ 1	30	7.0
Cord round the body	-	36	8.4
Cord knots	-	62	14.5
Hypocoiled cord	< 0.01	42	9.8
Hypercoiled cord	> 0.03	41	9.6

Abnormalities were defined by the 10^{th} and 90^{th} percentiles.

When the abnormalities defined in Table 5 were compared with foetal outcome, only gestational age was statistically related to cord length abnormalities (P= 0.0093). Other abnormalities were not related to foetal outcome statistically. However, the cord length had correlation with some other parameters as shown in Table 6.

Table 6
correlation between umbilical cord length and other parameters

Other Umbilical Parameters	Umbilical Cord Length	P-value
Number of Helices	0.308	< 0.001*
Number of Knots	0.277	0.029*
Number of Arteries	0.116	0.016*
Number of Veins	-0.118	0.016*
Umbilical cord coil index	-0.237	<0.001*

R: Pearson correlation coefficient

DISCUSSION

The range of cord length in this study was wider than the findings of Adinma and Balkawade et al in a series of 1,000 patients in Eastern Nigeria and India respectively. While the average cord length in our study and Igbo parturient were similar (52.68 cm and 51.5 cm), a mean value of 63.86 cm was reported in India. It is likely that the observed difference is due to racial variation even though, the findings are comparable. The wide ranges of the lengths in these studies support the variable nature of cord length in humans (6,11). Umbilical cord length showed a weak positive correlation with gestational age at delivery which was significant. That is an increase in gestational age will lead to an increase in umbilical cord length, suggesting that the cord grows as the foetus does. The increase in cord length with the increase in gestational length (R = 0.143, P = 0.003) is similar to findings in earlier studies (6,11,12). The usual assumption that the cord stops growing after 28 weeks of gestation is not supported by this study.

Studies have shown the linear correlation between cord length and foetal complications (11,13). Our study included apparently healthy women with no observed significant adverse maternal conditions. This may explain the low incidence of adverse foetal outcome in the study population.

The incidence of umbilical knots was14.5% in this study and it is much higher than 1.25% as reported by Airas *et al* in a population based analysis of 288 singleton pregnancies. Their report included only true knots. In addition, the incidence of true knot was associated with advanced maternal age, multiparity, male foetus and long cord whereas, no similar associations were observed in this study. However, the length of the cord was an important correlate of cord knots in this study. We therefore opined that the occurrence of umbilical knots may be determined by various independent characteristics of the foetus or mother.

Although there was no association between congenital abnormalities, maternal age and parity in this study, there was a correlation between number of umbilical vessels and parity. The negative correlation of single umbilical artery with parity is comparable to findings of Lilja in Sweden (14).

Single umbilical artery is associated with low birth weight babies and preterm deliveries. It was also more common in women above 40 years and those with three or more parous experiences (14). Neonates with single artery have increased risks of congenital and chromosomal abnormalities as well as adverse perinatal outcome (2,15). This probably explains the association of single umbilical artery with advanced maternal age and increased parity as seen in this study. In addition, a limitation in our design was that no chromosomal studies were carried out on these infants and some might have occurred without being reported.

This study has further evaluated the association between single umbilical artery and high parity. We therefore recommend the identification of single umbilical artery as a criterion for chromosomal and congenital anomalies screening especially in a low resource setting. The determination of the cord coil index in addition, may also be informative, as this parameter was also significantly related to occurrence of congenital anomalies in the study population. The cord length, vessels and coil index are important parameters with clinical significance in this study. Their documentation as part of routine postnatal examination like birth and placental weights may provide more information on foetal well being and neonatal outcome. The prenatal assessment of the umbilical cord is therefore desirable.

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