

Umbilical cord length and cord abnormalities in term singleton pregnancy: a review of pregnancy outcome in a tertiary health institution in Nigeria

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Objective To determine the association of fetomaternal outcomes of term pregnancies with fetal umbilical cord lengths and cord abnormalities in Calabar.

Methods A cross-sectional study of 600 women with singleton pregnancies who delivered either virginally or caesarean section between 37 and 42 completed weeks. Examination of cord was done at delivery for loop round neck, cord length, knots and cord abnormalities. Outcomes recorded include fetal presentation, sex, birth weight, length of newborn and Apgar scores at 1st and 5th min. Also, mode of delivery, labor duration and maternal complications were noted. Cords with abnormalities were sent for histological examination. Data was analyzed using SPSS version 20. Level of significance was set at P -value < 0.05.

Results The mean cord length was 61.07 ± 14.931 cm, short cords were 23 (7.7%), long cords were 37 (12.3%) and 480 (80.0%) were normal length. Male fetuses had longer cords, mean cord length in the vertex presentations were significantly longer than in breech presentation and increased with increase in birth weight. Abruptio placentae was higher among fetuses with short umbilical cord (17.4% vs. 0.4%) (P -value = 0.000). There was positive correlation between fetal weight and umbilical cord length. Cord coiling index showed a negative correlation with cord length ($r = -0.261$; P -value = 0.000).

Conclusion Abnormal umbilical cord lengths significantly predispose to obstetric complications but cord abnormalities are rare and does not affect pregnancy outcome. High index of suspicion and careful evaluation of cord may inform and reduce untoward fetomaternal outcome.

Keywords umbilical cord, length, complications, obstetric outcome

Introduction

The umbilical cord (also called the naval string, birth cord or funiculus umbilicus) is a conduit between the fetus and the placenta and indeed the lifeline of the fetus.¹ It develops from the remnants of the yolk sac and allantois.¹ The umbilical cord serves very important functions which includes delivering oxygen rich blood through the umbilical vein to the fetus. The umbilical cord also serves as a source of nutrient, including calories, proteins, fats, as well as vitamins to the fetus.² The umbilical cord also transfers waste products and deoxygenated blood away from the fetus to the maternal circulation, where it can be processed and excreted.

The umbilical cord length at term has appreciable variation with extremes ranging from no cord to lengths up to 300 cm.^{3,4} At birth, the mature normal umbilical cord is between 50 and 60 cm in length and 37.7 ± 7.73 mm in diameter.^{1,3}

The umbilical cord can be long or short and there may be as many as 40 spiral twists in the cord as well as false and true knots.³ Short cords, defined as cords <32 cm long, are seen in 0.4–0.9% of pregnancies and some studies revealed an incidence of up to 3–10% of all umbilical cords.^{1,5–7} Long cords, defined as cords length longer than 80 cm according to some studies or 100 cm according to others, are seen in 3.7–4% and 0.5% of all umbilical cords during pregnancies respectively.^{1,6} Umbilical cord length is one of the factors documented as a definite risk for poor fetal outcome.⁸ There is an association of abnormal cord length with neurological abnormalities and low IQ values.^{6,9} Excessively long or short cord may be the cause of

hematoma and thrombosis of cord vessels and the placental surface, thus causing fetal death and or thrombocytopenia.¹⁰

Causes of differences in cord length are unknown; however, the length of the umbilical cord is thought to reflect the sufficient space in the amniotic cavity for movement and the tensile strength applied to the umbilical cord during fetal movement.¹¹

A short cord may be due to reduced fetal activity (such as with twinning; monoamniotic and conjoined), as a primary failure of elongation, and in association with sirenomelia (lack of adequate fetal blood pressure), schisis, anencephaly (lack of hypothalamic hormones), acardia (cardiac output) and adhesions (early amniotic rupture sequence).⁶ It may also be due to oligohydramnios, amnion rupture, uterine structural anomalies as well as substances such as alcohol and beta blockers.⁵ Short cords can interfere with the mechanics of labor and delivery while exhibiting changes in fetal heart rate patterns.^{6,12} This restriction of descent (which is relative to the placental position and insertion) leads to an increase in the incidence of caesarean section, forceps and vacuum extractions. Other complications of excessively short cords include delay in second stage of labor, retained placenta, placental abruption, rupture of umbilical cord, inversion of uterus, birth asphyxia, and cord herniation.³

On the other hand, long umbilical cord is directly associated with poor fetal outcome and umbilical cord accidents especially; fetal entanglement and true knots.⁶ Placental changes are associated with long cords suggesting blood flow disruption or

increased resistance.¹² Male cords are longer than female cords and term vertex fetuses may have longer lengths than term breech fetuses.⁶ Multigravida cord length may be longer than primigravida cord length. Other complications of excessively long umbilical cords include cord prolapse, torsion, and delivery complications. There are also more cases of fetal distress, fetal anomalies, and respiratory distress.³ A multivariate analysis of a small sample of pregnancy reported an association with long cords and intrauterine growth restriction.⁶

The length of the umbilical cord and its position within the amniotic fluid are of great clinical relevance and is associated with a wide range of unfavorable obstetric outcome and this study aims to determine the relationship between length and abnormalities of the umbilical cord and obstetric outcome. Though the pathogenesis of variability of umbilical cord length remains largely unclear, fetal demise or compromise due to cord complication could be a source of depression to the obstetrician, medical community and the mother. In our locality, there is scarcity of data on umbilical cord length and cord abnormalities with relation to fetomaternal outcome. This study would provide information about the length of umbilical cord and cord abnormalities, its association with adverse obstetric outcome in our locality. This will increase awareness, guide obstetricians to pay more attention to, and carefully evaluate umbilical cord length and possible abnormalities to avoid untoward perinatal complications.

Materials and Methods

This study is a prospective cross-sectional study carried out at the labor ward and theatre of Obstetrics and Gynaecology Department of University of Calabar Teaching Hospital, Calabar. It is a tertiary health facility located in Calabar, South of Nigeria. Ethical approval was obtained from the Research and Ethics Committee of the Hospital. The study was carried out over a 5-months period between February 15 and July 14 2016. Simple random sampling was used to select participants for the study. The inclusion criteria were primigravida or multigravida with singleton pregnancies who had either vaginal delivery or caesarean section between 37 and 42 completed weeks. Pregnancies complicated by intrauterine fetal death, multiple gestations, congenital malformations of fetus, diabetes, preeclampsia, chorioamnionitis, preterm labor and intrauterine growth restriction were excluded from the study. The socio-demographic characteristics were obtained using pretested questionnaire and this includes initials of clients, hospital number, age, marital status, parity, last menstrual period and gestational age in weeks. Before delivery, fetal presentation, lie and position were determined by abdominal palpation. The mode of delivery was also noted. At delivery the umbilical cord was examined for the following: the presence of any loop around neck, trunk, cord knots (true or false) and any cord abnormalities such as cyst, hematoma, and velamentous insertion.

After the delivery of fetus, the umbilical cord was clamped at two places and cut in between. The length of the umbilical cord was measured from the cut end up to fetal umbilicus and from the other cut end to the placental attachment and the two measurements added to obtain the umbilical cord length. It was measured with flexible tape in centimeters. Other abnormalities of the umbilical cord after delivery were noted clinically.

Lengths of cords were measured and labelled as long (≥ 80 cm), short (≤ 32 cm) or normal (between 32 and 80 cm).

Thereafter umbilical cords with abnormalities were sent for histological analysis.

Type of insertion on the placenta was also noted. The placenta was examined under running water to remove blood clots and the placental weight measured using a weighing scale and recorded in grams. Fetal parameters that were recorded after the time of delivery include Apgar scores at 1 and 5 min, sex of the newborn, weight of the newborn and length of newborn (by measuring the distance between the crown and the heel). Maternal complications of labor and delivery which includes poor descent of presenting part, prolonged second stage of labor and placental abruption were also noted.

Data obtained were analyzed using the Statistical Package for Social Sciences version 20. Level of significance was set at P -value < 0.05 .

Results

During the study period, there were 1433 deliveries, 600 of the parturient were recruited for the study. Umbilical cord length varied from 20 to 110 cm with mean length of 61.07 ± 14.931 cm. Short umbilical cords were 46 (7.7%), normal cord were 480 (80.0%) while long cords were 74 (12.3%). Vaginal delivery was 412 (68.7%) while caesarean section was 188 (31.3%). The mean umbilical cord length was 61.07 ± 14.93 cm, mean gestational age 38.94 ± 1.326 weeks and mean parity 2.21 ± 1.239 .

Table 1 outlines the socio-demographics characteristics of the parturient. Majority of the parturient were between 30 and 34 years of age (38.0%), married (97.7%) and women in their first and second pregnancy (para 1 and 2) (66.0%). Mean umbilical cord length was longer among the age group of 20–24 (63.13 ± 15.69 cm), married women (61.30 ± 14.86 cm) and women in their third and fourth pregnancy (para 3 and 4) (63.27 ± 14.82 cm).

The male fetuses generally had statistically significant longer umbilical cord length than female fetuses (63.74 ± 15.66 cm vs. 57.97 ± 13.44 cm) as shown in Table 2. The mean cord length in the vertex presentation group was significantly longer than the breech group (61.23 ± 14.95 cm vs. 54.29 ± 13.25 cm). The mean umbilical cord length increased with increase in birth weight and there was statistically significant difference between umbilical cord lengths and birth weight.

Longer umbilical cords were significantly hypocoiled while shorter umbilical cords were hypercoiled. Placental weight group of 0.9–1.0 kg had the longest mean umbilical cord length and there was statistically significant difference between placenta weight and umbilical cord length (P -value = 0.018). There was no statistically significant difference between umbilical cord lengths and umbilical cord abnormalities (P -value = 0.925).

Figure 1 shows the distribution of umbilical cord complications. Most parturient had no umbilical cord complications (82.3%) and the most common complication was nuchal cord (12.0%). True knot occurred in 1%, cord round body in 4% while cord prolapse was 0.7%.

Table 3 shows the correlation between umbilical cord length and fetomaternal outcome. When the umbilical cord length was compared with placental weight using the Pearson's correlation, there was significant positive correlation between placental weight and umbilical cord length ($r = 0.212$; P -value = 0.000). There was also significant positive correlation between umbilical cord length and fetal weight. Umbilical

Table 1. The fetoplacental characteristics in relation to mean cord length

Variables	Frequency (%)	Cord length (cm)		Test statistics
		Mean	SD	
Sex				
Male	161	63.74 ± 15.66		4.8428 <0.001
Female	139	57.97 ± 13.44		
Lie/Presentation				
Vertex	293	61.23 ± 14.95		6.0171 <0.001
Breech	7	54.29 ± 13.25		
Fetal weight				
<2.5 kg	9	60.52 ± 15.05		1.813 0.046
2.5 ≤ 4.0 kg	269	64.33 ± 14.57		
4.0 kg and above	22	66.41 ± 12.85		
Length of the neonate				
Below normal <45	4	64.75 ± 18.998		0.216 0.806
Normal 45–55	289	60.98 ± 15.012		
Greater normal >55	7	63.43 ± 9.846		
Cord coiling index				
Hypo-coiled <0.17	129 (43.0)	65.32 ± 12.61		10.904 0.000
Normal 0.17–0.37	165 (55.0)	58.18 ± 15.46		
Hypercoiled >0.37	6 (2.0)	49.17 ± 22.61		
Types of umbilical cord insertion				
Centric	151 (50.4)	61.21 ± 14.775		0.241 0.869
Eccentric	103 (34.3)	61.58 ± 15.288		
Marginal	45 (15.0)	59.38 ± 15.01		
Vilamentous	1 (0.15)	63.00		
Placental weight (kg)				
0.1–0.2	1 (0.3)	64.00		2.777 0.018
0.3–0.4	24 (8.0)	57.25 ± 15.098		
0.5–0.6	121 (40.4)	58.4 ± 15.837		
0.7–0.8	129 (43.0)	62.96 ± 13.832		
0.9–1.0	22 (7.3)	68.82 ± 12.764		
>1.0	3 (1.0)	59.67 ± 14.154		
Cord abnormalities				
None	297 (99.0)	61.10 ± 14.973		0.078 0.925
Single umbilical artery	2 (0.7)	57.50 ± 16.263		
Umbilical cord cyst	1 (0.3)	58.00		

Table 2. Correlation between length of umbilical cord with maternal characteristics and obstetric outcome

Obstetrics outcome	Umbilical cord length	
	Correlation (r)	P-value
Birth weight	0.179	0.037*
Gestational age	0.089	0.124
5 th minute Apgar score	−0.022	0.703
Length of neonate	0.066	0.255
Maternal age	0.002	0.975
Parity	0.065	0.260
Duration of labor	0.100	0.085
Umbilical cord coiling index	−0.261	0.000*
Placental weight	0.212	0.000*

*Correlation is significant at <0.05 levels (two-tailed).

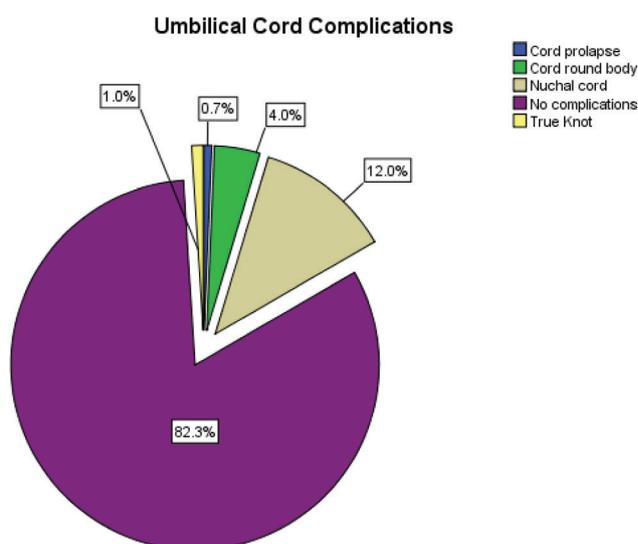


Fig. 1 Umbilical cord complications.

Table 3. The relationship between umbilical cord length and fetomaternal outcomes

Variables	Feto-maternal outcome		Chi-square	P-value
	<7	≥7		
1st minute Apgar				
Short cord	2 (8.6)	21 (91.3)	0.60	0.752
Long	8 (21.6)	29 (78.4)		
Normal	35 (14.6)	205 (85.4)	Referenced	
5th minute Apgar				
Short cord	2 (8.6)	21 (91.3)	0.30	0.639
Long	3 (8.1)	34 (91.9)		
Normal	14 (5.8)	226 (94.2)	Referenced	
Delayed 2nd stage				
	Yes	No		

(Continued)

Table 3. The relationship between umbilical cord length and fetomaternal outcomes—Continued

Variables	Feto-maternal outcome		Chi-square	p-Value
Short cord	2 (8.7)	21 (91.3)	3.54	0.117
Long	1 (2.7)	36 (97.3)	0.06	0.581
Normal	5 (2.1)	235 (97.9)	Referenced	
Abruptio placentae	Yes	No		
Short cord	4 (17.4)	19 (82.6)	32.42	0.000
Long	1 (2.7)	36 (97.3)	2.34	0.249
Normal	1 (0.4)	239 (99.6)	Referenced	
Low birth weight (<2.5 cm)	Yes	No		
Short cord	2 (8.7)	21 (91.3)	2.12	0.181
Long	1 (2.7)	36 (97.3)	0.01	1.000
Normal	7 (2.9)	233 (97.1)	Referenced	
Macrosomia (>4 kg)	Yes	No		
Short cord	1 (4.3)	22 (95.7)	0.04	1.000
Long	3 (8.1)	34 (91.9)	0.08	0.968
Normal	19 (7.9)	221 (92.1)	Referenced	
Cord round neck	Yes	No		
Short cord	0 (0.00)	23 (100)	2.88	0.088
Long	9 (24.3)	28 (75.7)	4.85	0.028
Normal	27 (11.3)	213 (88.7)	Referenced	
Breech presentation	Yes	No		
Short cord	2 (8.7)	21 (91.3)	4.65	0.031
Long	1 (2.7)	36 (97.3)	0.19	0.514
Normal	4 (1.7)	236 (98.3)	Referenced	

Table 4. The maternal characteristics in relation to mean cord length of the study population

Variables	Frequency (%)	Cord length (cm)
		Mean ± SD
Age (years)		
14–19	11 (3.7)	58.64 ± 23.61
20–24	30 (10.0)	63.13 ± 15.69
25–29	97 (32.3)	60.47 ± 14.57
30–34	114 (38.0)	61.24 ± 14.93
35 and above	48 (16.0)	61.13 ± 13.17
Marital status		
Married	293 (97.7)	61.30 ± 14.86
Single	7 (2.3)	51.14 ± 15.65
Parity		
1–2	198 (66.0)	60.20 ± 15.09
3–4	86 (28.7)	63.27 ± 14.82
5 and above	16 (5.3)	59.94 ± 13.03

cord coiling index showed a significant negative correlation with umbilical cord length ($r = -0.261$; P -value = 0.000).

Abruptio placentae was significantly higher among fetuses with short umbilical cord than normal umbilical cord length (17.4% vs. 0.4%) and this difference was statistically significant (P -value = 0.000). Cord round neck was significantly higher among long umbilical cord than the normal umbilical cord length control (P -value = 0.036).

Discussion

Several studies concerning umbilical cord length at term showed that umbilical cord length varies from no cord to lengths up to 300 cm and mature umbilical cord is between 50 and 60 cm in length.^{1,2,4} In this study the mean umbilical cord length was 61.07 cm and ranged from 20 to 110 cm. This study is comparable with the findings in Sudan where the mean cord length was 60.5 cm¹³ and Agwu et al.¹⁴ in Abakaliki, Nigeria where the mean cord length was 57 cm and ranged from 22 to 124 cm. However, this was higher than 52.7 cm reported in Ilorin by Adesina et al.¹⁵ This showed that human neonates exhibit wider variations in terms of the length of their umbilical cord as earlier documented by Jaya et al.¹⁶ and Stefos et al.¹⁷ respectively. The reason for the difference in the mean values of umbilical cord length obtained in these studies is not very clear but may be because umbilical cord length is influenced by environmental and genetic factors.¹⁶ Although it is not fully understood what controls cord length, various authors correlate cord length with fetal activity and movement.¹⁸ It is suggested that sufficient space in the amniotic cavity for movement and the tensile force applied to the umbilical cord during fetal movements are two main factors that determine cord length. However, more recent studies using animal models have argued against the “stretch hypothesis,” stating that the umbilical cord continues to grow throughout pregnancy in an almost linear fashion.^{5,15}

The incidence of short cords in this study was 7.7% of all deliveries is similar to the incidence of 5.9% in the study by Balkawade and Shinde³ and 7.2% by Adesina et al.¹⁵ This finding is also similar to other reported incidence of short cords which ranged from 2% to 10%.^{13,14,19} The incidence of 7.7% in this study is however higher than 0.7% reported in Abakaliki, Nigeria.¹⁴ The marked difference in the reported low prevalence of short cord in that study may have been influenced by the low cut off of <32 cm used in the definition of short umbilical cord.

In this present study, the incidence of long umbilical cord was 12.3% which is higher than 7% by Agwu et al.¹⁴ and 9.3% by Adesina et al.¹⁵ The significance of long umbilical cords resides in the fact that they may be directly associated with poor fetal outcome and umbilical cord accidents such as fetal entanglement, knot formation (multiple) and torsion.⁹

This study showed that the male fetuses had statistically significant longer umbilical cord length than the female fetuses and there was a significant positive correlation between the sex of neonate and umbilical cord length. This may be explained by the fact that male fetuses normally weigh more than their female counterparts and also by the fact that length of umbilical correlates significantly with birth weight. This is consistent with the findings of Krakowiak et al.⁵ who demonstrated that female infants had shorter cords than male infants.

In this present study, the mean umbilical cord length increased with increase in birth weight and umbilical cord

length was positively correlated with birth weight. Fetuses with longer umbilical cord were likely to have normal birth weight or to be macrosomic. This could be explained by the fact that as the fetus grows the umbilical cord also increases in length. Agboola²⁰ also reported a significant positive correlation between cord length and fetal weight. Wu et al.²¹ in their series using stepwise logistic regression for multivariate analysis of the relationship between umbilical cord length and obstetric outcome found a statistically significant relationship between umbilical cord length and birth weight.

Concerning umbilical cord index, 43% were hypocoiled, 55% normocoiled and 2% hypercoiled. Umbilical cord coiling index showed a significant negative correlation with umbilical cord length which means that with increase in umbilical cord length, the coiling index decreases.

Abnormal coiling (hypo-coiling and hyper-coiling) is known to have chronic (growth retardation) and acute (fetal intolerance to labor and fetal demise) effects on fetal well-being.^{22,23} The vessels of the umbilical cord are prone to torsion, compression, tension, and subsequent interruption of the blood flow. This risk is minimized by their helical disposition. It is possible that the coiled umbilical cord has elastic properties that enable it to resist external forces that might compromise the umbilical vascular flow. It may be that, the coiled umbilical cord acts like a semi-erectile organ that is more resistant to snarling torsion, stretch, and compression than the non-coiled one. Hypercoiled cords often have more thrombi in placental surface veins because the flow is more sluggish, and when coiling becomes excessive, the fetus can strangle due to decreased circulation in the cord vessels.^{24,25} Ercal et al.²³ when comparing neonates with hypocoiled and normocoiled found a higher incidence of meconium staining, interventional delivery, Apgar scores, fetal blood pH and intrapartum fetal heart rate disturbance in neonates with hypocoiled cords and concluded that umbilical cord index has a strong relationship with perinatal outcome. Thus, detection of an abnormal coiling index can lead to identification of fetuses at risk which need special care to improve perinatal outcome.

There was statistically significant difference between umbilical cord length and placenta weight in this study. The placental weight showed significant positive correlation with umbilical cord length which means that umbilical cord length increases with increase in placental weight. It then implies that, factors which directly affect the weight of the placenta will indirectly affect the length of the umbilical cord. Such factors include nutrition, maternal anemia, altitude, hypertension, maternal diabetes mellitus and other chronic medical illness.

An abnormal placental cord insertion site has been associated with a number of complications of pregnancy that may result from compression or rupture of poorly supported umbilical vessels.¹ Intrapartum hemorrhage, fetal bradycardia, stillbirth, intrauterine growth restriction and preterm labor have all been linked to velamentous and to a lesser extent, marginal cord insertions.^{1,26} In this present study, there was only a single reported case of velamentous umbilical cord insertion and there was no adverse maternal, fetal or perinatal outcome associated with it. In a study conducted by Adesina et al.,¹⁵ velamentous cord insertions occurred in 1.1% and 0.9% respectively of singleton pregnancies.

Several articles concerning umbilical cord length and fetomaternal outcome have been published in the past with conflicting reports.^{1,6,14,21} Various reports have demonstrated that a short umbilical cord was associated with birth asphyxia, abruptio placentae, breech presentation and prolonged second stage of labor. Krakowiak et al.⁵ in their study reported an increase in hypoxic-ischemic encephalopathy, fetal distress, and infant death and low birth weight and a twofold increase in risk of death among term infants born with short cords. On the contrary, a long umbilical cord was frequently associated with cord accidents and fetal distress. In this study, only abruptio placentae and breech presentation were significantly higher among fetuses with short umbilical cord than normal umbilical cord length control. Also, only cord round neck was significantly higher among long umbilical cord than the normal umbilical cord length control. Low birth weight, macrosomia and delayed second stage of labor were not significantly different among long and short umbilical cord compared with normal cord length control. This study also did not find an increase in intrapartum fetal distress and birth asphyxia with length of umbilical cord. This finding is similar to the study in Taiwan where multivariate analysis of the relationship between umbilical cord length and obstetric outcome found no association between umbilical cord length and antepartum and intrapartum fetal wellbeing.²¹ However, this is in contrast to the study where Agwu et al.¹⁴ found an increase intrapartum fetal distress and birth asphyxia in the long cord arm group. The difference with study may be related to the difference in patients' selection for the study, intrapartum monitoring and caesarean sections rates in different studies.

Umbilical cord abnormality was 1% of total deliveries. There was no significant association between varying umbilical cord lengths and umbilical cord abnormalities. This may be due to rarity of these abnormalities as it occurs in 1% of live birth from other studies also.^{14,15,27} Another study also reported an incidence of 0.2%. Adesina et al.¹⁵ noted that single umbilical artery is associated with low birth weight babies and preterm deliveries. Neonates with single artery have increased risks of congenital and chromosomal abnormalities as well as adverse perinatal outcome.²⁷ The two neonates with single umbilical cord had moderate birth asphyxia but made good recovery in the perinatal period and there were no obvious congenital anomalies among them.

This study did not utilize the intrapartum evaluation with Doppler ultrasound to possibly determine cord length and abnormalities as to reduce fetomaternal complications during delivery. Further research is therefore needed to determine the umbilical cord characteristics using high definition Doppler ultrasound and relationship with obstetric outcome.

Conclusion

The study showed that the length of umbilical cord varied from 20 to 110 cm with mean of 61.07 ± 14.931 cm. Abruptio placentae and breech presentation were significantly higher among fetuses with short umbilical cord than normal and cord round neck was significantly higher among long umbilical cord than the normal cord length. Cord abnormalities were very rare and there were no significant association between umbilical cord lengths and umbilical cord abnormalities from this study. Appropriate examination and documentation of umbilical cord length and abnormalities is necessary. This will

provide more information on fetal well-being, neonatal outcome and basis for further studies. Ante partum or intrapartum obstetric ultrasound scan for possible abnormal cord lengths and cord abnormalities may reduce untoward pregnancy outcome.

Conflicts of Interest

None. ■

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