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**Original Article**

# A GESTATIONAL AGE RELATED STUDY OF LENGTH AND DIAMETER OF UMBILICAL CORD AND THEIR CORRELATION WITH BIRTH WEIGHT

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**ABSTRACT**

The umbilical cord connects the fetus to the placenta for gaseous exchange, waste elimination and nutrient uptake. The umbilical cord along with the placenta is disposed off as medical waste after birth. But, the umbilical cord can prove to be a marker of certain adverse prenatal conditions. A short cord may cause traction during delivery, placental abruptions, uterine inversion or cord herniations. Abnormally long cord may lead to conditions like true knots, cord prolapse and coiling of the cord around fetal parts. Thin cords are found to be associated with intrauterine growth retardation (IUGR), small for gestational age babies (SGA) and low birth weight (LBW). The present study of 500 umbilical cords recorded the length and diameter of umbilical cords and their relationship with gestational age group and birth weight. Important variations in umbilical cord length and diameter were observed in the study. The length of the umbilical cords was found to have a range of 32.50 to 76 cm with a mean of 54.66 ± 7.09 cm. The umbilical cord diameter had a range of 0.8 cm to 1.60 cm with an average of 1.23 ± 0.19 cm. There was no significant difference found either in the mean cord length or mean cord diameter among different gestational age groups. Umbilical cord length was found to have a significant positive correlation with birth weight. However, the study did not find statistically significant correlation between cord diameter and birth weight.

**KEYWORDS: Umbilical Cord, Cord Length, Cord Diameter, Birth Weight,**

## INTRODUCTION:

A normal umbilical cord is very crucial for the normal growth and development of the foetus. Linde, Rasmussen, Kessler and Ebbing (2018) stressed on the increasing awareness on cord abnormalities and their associated risk on maternal and foetal health. The length of the cord is an important parameter for normal foetal activity and is responsible for the tension caused by the freely moving foetus, mainly during the second trimester. Short cord may be associated with foetal akinesia or maldevelopment of the central nervous system and can prove to be an early marker of developmental abnormalities like Down syndrome (Ente & Penzer, 1991). While short cords may be related to fetal distress, fetal malformations, placental abruption, etc; excessively long cords may be associated with cord entanglements, fetal thrombotic vasculopathy, emergency deliveries and increased risk of neurological complications (Linde et al, 2018). Ente and Penzer (1991) stated that abnormal diameter of the cord should draw one's attention to the possibility of an umbilical hernia or a patent urachus and caution should be exercised before clamping. Sun, Arbuckle, Hocking, and Billson (1995) observed that thin umbilical cord have been

seen to be associated with adverse pregnancy outcome while Raio et al (1999) found lean umbilical cord to be associated with SGA deliveries. Goynumer, Ozdemir, Wetherilt, Durukan and Yayla (2008) reported significant differences in mode of delivery, birth weight, mean gestational age and adverse perinatal outcome between fetuses with cord thickness below 5$^{th}$ centile (lean umbilical cord) and above the 5$^{th}$ centile (non-lean cord) in the early stages of gestation.

Although average dimensions of umbilical cords are available, these may not be universally applied to all races and regions as they may show significant differences which in turn should affect our clinical decisions. However, regional reference of umbilical cord dimensions are not readily available which may be attributed to it being disposed off as medical waste soon after birth. Knowledge of the umbilical cord parameters is clinically important as several umbilical cord abnormalities are known to cause adverse prenatal outcome. But due to paucity of data, most clinicians follow the standard international data available. This study therefore aims to observe the length and diameter of the umbilical cord at the time of birth so as to give a reference range of these parameters particularly in the North East Indian population which is ethnically quite different from the rest of the world. The study also aims to assess if there is any significant difference of these measurements in different gestational age groups. The study also correlates the length and diameter of the cord with birth weight, which has been accepted as an important parameter of foetal well being.

**METHODOLOGY:**

The study was conducted in the Department of Anatomy, Assam Medical College & Hospital, Dibrugarh, Assam in collaboration with the Department of Obstetrics & Gynaecology, Assam Medical College and Hospital (AMCH), Dibrugarh, Assam, for a period of one year from July 2012 to June 2013. Ethical clearance was obtained from the Institutional Ethics Committee, Assam Medical College, Dibrugarh, Asssm, India.

A total of 500 umbilical cords (275 males, 225 females) were observed during the study. Among them, 105 cords (62 males, 43 females) belonged to 36-37 weeks gestational age group, 330 cords (178 males, 152 females) belonged to 38-39 weeks gestational age group and 65 cords (35 males, 30 females) belonged to ≥ 40 weeks gestational age group, Umbilical cords were collected from the Labour Room and Obstetrical O.T. in the Department of Obstetrics & Gynaecology, Assam Medical College and Hospital.

Inclusion criteria included cords which were immediately available after delivery from mothers who were apparently healthy and had completed 36 weeks of pregnancy. Exclusion criteria included cords from mothers suffering from systemic diseases (eg: diabetes, thyroid disorder, etc), history of infectious disease or bleeding per vagina. Cords with knots or cysts, cords from foetuses suffering from obvious congenital abnormalities, cords from cases of abruptio placenta, pacenta previa or any other recognized cord trauma were also excluded from the study. Length and diameter of the umbilical cords were measured immediately following delivery. The cord length was measured with a non stretchable measuring tape. Measurements were taken in centimeter from the placental end to the cut end (Fig 1a) and from the cut end to the fetal end (Fig 1b) including any cut part to give the total cord length.

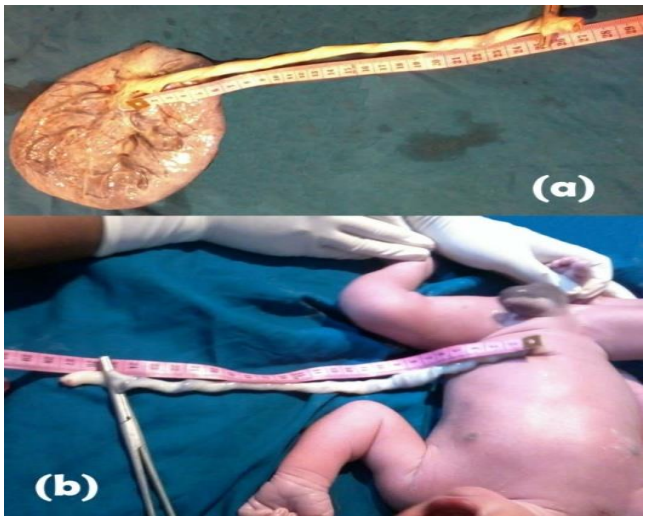


**Fig 1: Measurement of Umbilical cord length (a) from placental end to cut end (b) from cut end to foetal end**

The diameter of the umbilical cord was measured in centimeters using a slide caliper (Fig 2). The measurements were taken at three places for each cord: the fetal end, the maternal end and at the middle of the cord, from which the mean were calculated for each cord.

**Fig 2: Measurement of Umbilical Cord diameter using slide caliper.**

The baby's weight was recorded in grams with the help of a digital weighing machine. The cord parameters were recorded and analyzed with respect to gestational age groups.

Statistical Analysis was done by using ANOVA (Analysis of Variance), Chi-square test and correlation co-efficient.

## RESULTS:

The length of the umbilical cords were found to have a range of 32.50 to 76 cm with a mean of 54.66 ± 7.09 cm (Table 1). However, no significant difference in the mean cord length among different gestational age groups was found ($p>0.05$).

**TABLE–1: AVERAGE UMBILICAL CORD LENGTH IN MALES AND FEMALES OF DIFFERENT GESTATIONAL AGE GROUPS**

| GESTATIONAL AGE *(in weeks)* | MALE | | FEMALE | | TOTAL | | Range*(cm)* |
|---|---|---|---|---|---|---|---|
| | *Mean (cm)* | ± *S.D.* | *Mean (cm)* | ± *S.D.* | *Mean (cm)* | ± *S.D.* | |
| 36—37 | 54.29 | 8.30 | 53.31 | 7.10 | 53.89 | 7.81 | 36–71.5 |
| 38—39 | 55.25 | 6.71 | 54.07 | 6.12 | 54.71 | 6.46 | 32.5–76 |
| ≥ 40 | 55.94 | 9.65 | 55.40 | 7.61 | 55.69 | 8.71 | 32.5–73.7 |
| TOTAL | 55.12 | 7.50 | 54.10 | 6.52 | 54.66 | 7.09 | 32.5- 76 |

The range of umbilical cord diameter varied between 0.8 cm and 1.60 cm with an average of 1.23 ± 0.19 cm (Table 2). Statistically, no significant difference in the mean cord diameter was found among different gestational age groups ($p>0.05$).

**TABLE–2: AVERAGE CORD DIAMETER IN DIFFERENT GESTATIONAL AGE GROUPS**

| GESTATIONAL AGE *(in weeks)* | NUMBER *(n)* | UMBILICAL CORD DIAMETER *(Mean ± S.D.) cm* | Range *(cm)* |
|---|---|---|---|
| 36—37 | 105 | 1.21 ± 0.19 | 0.87 - 1.58 |
| 38—39 | 330 | 1.23 ± 0.18 | 0.80 - 1.60 |
| ≥ 40 | 65 | 1.23 ± 0.19 | 0.85 - 1.58 |
| TOTAL | 500 | 1.23 ± 0.19 | 0.80 – 1.60 |

When birth weight was compared to the length of the umbilical cords (Table 3), a significant positive correlation was found. ($p<0.05$, $r = 0.16$). However, when cord diameter and birth weight were compared, no significant correlation was found ($p>0.05$, $r = 0.02$) (Table 4).

**TABLE- 3: CORRELATION BETWEEN UMBILICAL CORD LENGTH AND BIRTH WEIGHT**

| UMBILICAL CORD LENGTH *(in cm)* | BIRTH WEIGHT *(in Kg)* | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|
| | <2.5 | | 2.5—3.5 | | >3.5 | | |
| | *number* | *%* | *number* | *%* | *number* | *%* | |
| <40 | 4 | 16.00 | 20 | 80.00 | 1 | 4.00 | 25 |
| 40—60 | 47 | 12.24 | 321 | 83.59 | 16 | 4.17 | 384 |
| >60 | 11 | 12.09 | 76 | 83.52 | 4 | 4.40 | 91 |
| TOTAL | 62 | 12.40 | 417 | 83.40 | 21 | 4.20 | 500 |

**TABLE- 4: CORRELATION BETWEEN UMBILICAL CORD DIAMETER AND BIRTH WEIGHT**

| UMBILICAL CORD DIAMETER *(in cm)* | BIRTH WEIGHT *(in Kg)* | | | | | | TOTAL NUMBER |
|---|---|---|---|---|---|---|---|
| | <2.5 | | 2.5—3.5 | | >3.5 | | |
| | *number* | *%* | *number* | *%* | *number* | *%* | |
| <1 | 10 | 16.13 | 43 | 10.31 | 1 | 4.76 | 54 |
| 1—2 | 52 | 83.87 | 374 | 89.69 | 20 | 95.24 | 446 |
| >2 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| TOTAL | 62 | 12.40 | 417 | 83.40 | 21 | 4.20 | 500 |

## DISCUSSION:

The cord length in the present study can be compared with data from different authors (Table 5). The present study did not show any significant difference in umbilical cord length among different gestational age groups which supports the findings of some authors (Naeye, 1985; Mills, Harley & Moessinger, 1983).

**TABLE–5: CORD LENGTH VALUES IN VARIOUS STUDIES**

| AUTHOR'S NAME | CORD LENGTH (MEAN/RANGE) |
|---|---|
| Walker & Pye, 1960 | 60 cm (mean) |
| Malpas, 1964 | 61 cm(mean), 30—129 cm (range) |
| Agboola, 1978-79 | 57.5 cm (mean) |
| Naeye, 1985 | 60 cm (mean) |
| Ente & Penzer, 1991 | 50-60 cm (range) |
| Adinma, 1993 | 51.5 cm (mean), 15—130 cm (range) |
| Moore & Persaud, 2008 | 55 cm (mean), 30-90 cm (range) |
| Balkawade & Shinde, 2012 | 63.86 (±15.69) cm (mean), 24 to 124 cm (range) |
| Suzuki & Fuse, 2012 | 56.2 ± 11.7 cm (mean), 19—133 cm (range) |
| **Present Study** | 54.66 (± 7.09) cm (mean), 32.50—76 cm (range) |

Cord diameter in the present study was compared with that found by other authors (Moore & Persaud, 2008; Sadler, 2010). Moore and Persaud (2008) found that the cords had a range of 1-2 cm while Sadler (2010) mentioned a mean diameter of 2 cm. Naro, Ghezzi, Raio, Franchi and Addario (2001) found a decline in umbilical cord diameter with an average of 16.72 ± 2.57 mm at 33–35 weeks and then decline to 14.42 ± 1.50 mm at 42 weeks gestation. However, the present study did not find any such decline in umbilical cord diameter. On the contrary, it found an insignificant increase in umbilical cord diameter with increasing gestational age (Table–2).

Agboola (1978-79); Nnatu S (1991); *Petekkaya, Deniz and Yildiz (*2011) indicated a positive correlation between cord length and birth weigh, which was in conformity with the present study ($p<0.05$, $r = 0.16$). But Walker and Pye (1960); Balkawade and Shinde (2012) did not find any such correlation. Low birth weight (LBW) is a birth weight of less than 2500 g (World Health Organization [WHO], 2010). In the present study, the percentage of LBW babies was seen to decrease with increasing cord length (Table–3). When cord diameter was correlated with birth weight, fetuses with a lean umbilical cord showed a higher chance of being SGA at birth (Raio et al,1999). Proportion of lean umbilical cords was higher in IUGR fetuses than in appropriate-for-gestational-age foetuses (Raio et al, 2003). Thin umbilical cord may be related to low infant birth weight (Proctor et al, 2013). In the present study, no statistically significant association was found between umbilical cord diameter and birth weight ($p>0.05$, $r = 0.02$), which supports the findings of some authors (Ghezzi et al, 2001). However, the study showed that percentage of thin cords (<1 cm) decrease as birth weight increases (Table 4)

Limitation of the study is that it has focussed only on birth weight to assess foetal well being. Birth weight was selected as it was one of the most vital parameter to assess foetal well being and can reflect important conditions like LBW, IUGR, SGA, etc. Further studies can be undertaken in future to correlate the cord dimensions with other foetal indicators like Apgar Score, cord

traction, placental abruptions, cord herniations, cord prolapse, foetal akinesia, fetal malformations, fetal distress, cord entanglements, emergency deliveries, patent urachus, umbilical hernia fetal death, etc. The present study showed a significant positive association between cord length and birth weight. Hence clinicians need to be careful of short cords. Early prenatal ultrasonographic determination of cord parameters like cord length may give an insight into foetal outcome that would keep clinicians ready for extra care during labour if necessary. The study will help us in better understanding of the anatomy of the umbilical cord which has so far been a neglected and discarded organ. This understanding can encourage further research into this subject and also prompt radiologists to keep an eye on these parameters during ultrasonographic assesments during pregnancy.

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