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Umbilical Cord Diameter at the Junction of the Body Wall in the Newborn. Is It a Biomarker for Congenital Umbilical Hernia?

Nazile Ertürk 

Faculty of Medicine, Department of Pediatric Surgery, Mugla Sitki Kocman University, Mugla, Turkey

ABSTRACT

Introduction: The aim is to obtain normal newborn umbilical cord diameters for use it in the evaluation of congenital umbilical hernia. **Materials and methods:** The umbilical cord diameter (UCD) at the abdominal wall, maternal age, birth weight, gestational age at birth, birth height, head, chest and abdominal circumferences, and the time of measurement after birth was noted. **Results:** Mean \pm standard deviation and median (minimum–maximum) values of the UCD were 9.9 ± 1.9 mm, 10.0 (5–16 mm), respectively. There was a significance for a positive low correlation between birth height and UCD ($p = .039$, $r = .143$). No other birth parameter had a significant correlation with UCD. The gender of the newborn ($p = .95$) and the type of delivery ($p = .056$) did not affect UCD. **Conclusion:** These data may be used in determining the normality of UCD, which could be helpful in the evaluation of umbilical hernias.

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KEYWORDS

Birth weight; congenital umbilical cord hernia; umbilical cord circumference; umbilical cord diameter

Introduction

The umbilical cord may be thought as the lifeline of the fetus (1). Umbilical cord involves two arteries and one vein surrounded by Wharton's jelly (2). The survival of the fetus requires a sufficiently functioning umbilical cord. The composition of the umbilical cord (arteries, vein, and Wharton's jelly) changes during the gestation (3,4).

The intestines are physiologically herniated towards the proximal part of the umbilical cord in the early fetal period. That is called extracoelomic cavity (5,6). The intestines migrate back to abdominal cavity in the 10–12th weeks gestation, the umbilical ring usually closes and the extracoelomic cavity disappears. The Wharton's jelly and the umbilical vessels form the resultant umbilical cord. On occasion, the umbilical ring does not close and intestines may remain in the extracoelomic cavity. This process is called congenital hernia of the umbilical cord (CHUC) in the postnatal period (5–9), which is estimated to occur once in 5000, with a male preponderance (3:1), and is associated with prematurity (10). In CHUC, cord clamping may cause intestinal obstruction, in that often ileum is contained within the sac (11). For this reason, the immediate evaluation of the diameter of the umbilical cord immediately after birth may have a predictive value for the diagnosis of CHUC.

CONTACT Nazile Ertürk  erturknazile@gmail.com  Mugla Sitki Kocman University, Faculty of Medicine, Department of Pediatric Surgery, Haluk Ozsoy Caddesi Mentese, Mugla 48000, Turkey.

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In this study, we aimed to assess the normal umbilical cord diameter data in the newborn and the relation between the umbilical cord diameter and some morphometric birth parameters.

Methods

Institutional Ethics Board Approval and a written informed consent were obtained before beginning the study. This prospective study included 209 term newborns. The inclusion criteria were: (1) singleton gestation, (2) normal amniotic fluid index during the pregnancy, (3) presence of three-vessel umbilical cord, (4) absence of any congenital anomaly, (5) absence of any known maternal disease, and (6) absence of any complications during pregnancy.

The umbilical cord diameter was measured at its attachment to the umbilicus by a digital caliper on the first day of hospitalization by the same doctor and nurses. Maternal age, birth weight, gestational age at birth, birth height, head circumference, chest circumference, abdominal circumference and the time after birth at which umbilical cord diameter was measured were noted for each newborn. Newborns infants were divided into six 4 h groups according to the time since birth. The average value of umbilical cord diameters in each group were measured and compared with each other. ANOVA test was performed to determine a significant difference in desiccation (shrinkage) among the groups.

All statistical data were analyzed using SPSS version 15.0 (SPSS Inc., Chicago, IL). Values were expressed as *mean, standard deviation and also as median (minimum–maximum)*. The normality of the values were analyzed by using Shapiro–Wilk test. For the independent samples, *t*-test or Mann–Whitney *U* test was used according to the Shapiro–Wilk test result. Correlations between the variables were investigated by using Spearman correlation coefficient. Differences were considered significant at $p < .05$.

Results

Maternal age, birth weight, gestational age at birth, birth height, head circumference, chest circumference, abdominal circumference, umbilical cord diameter and the time of measurement after birth are shown in [Table 1](#). All the morphological variables except birth weight had normal distribution. The 5% and 95% confidence interval limits of umbilical cord diameter were 9.8 and 10.1 mm, respectively.

Table 1. Tests of normality and descriptive statistics.

	Shapiro–Wilk			Mean	Standard deviation	Min–max	Median
	Statistic	df	Sig.				
Maternal age (years)	0.974	209	<0.001	27.8	5.3	15–41	26
Birth weight (kg)	0.992	209	0.359	3307.7	449.0	2030–4350	3310
Gestational age at birth (week)	0.907	209	<0.000	39.1	1.3	35–41	39
Birth height (cm)	0.937	209	<0.000	50.3	1.7	45–54	50
Head circumference (cm)	0.893	209	<0.000	34.5	1.1	31–37	35
Chest circumference (cm)	0.901	209	<0.000	33.2	2.1	27–45	33
Abdominal circumference (cm)	0.962	209	<0.000	29.5	2.4	22–40	29
Umbilical cord diameter (mm)	0.953	209	<0.000	9.9	1.9	5–16	10
Time after birth (h)	0.889	209	<0.000	11.5	7.5	1–24	10

The distribution of umbilical cord diameter measurements is shown in Figure 1. The data show a normal distribution. Except birth height, none of the birth parameters had a significant correlation with the umbilical cord diameter (Table 2). There was a significance for a positive low correlation between birth height and umbilical cord diameter ($p = .039$, $r = .143$, Table 2). Accordingly, although there is a low correlation, the birth height and the umbilical cord thickness increase together. The gender of the newborn ($p = .95$) and the type of delivery ($p = .056$) did not affect umbilical cord diameter (Table 3).

The newborns were divided into groups according to the median of the measurements for birth weight, chest circumference, abdominal circumference and head circumference. It was found that lower and higher values of those parameters did not affect the umbilical cord diameter (Fig. 2). Findings showed no significant difference in drying shrinkage among the groups during the first 24 h ($p = .871$) (Table 4).

Within the period of our study only one baby was born with CHUC, in which the cord diameter was 21.6 mm and contained a loop of intestine, covered by a thin membrane. A primary hernia closure was required and performed.

Discussion

The aim of this study was to obtain normal newborn umbilical cord diameters for use it in the evaluation of congenital umbilical hernia. The studies related to umbilical cord are generally about the length of the cord. The length of the cord increases mainly in

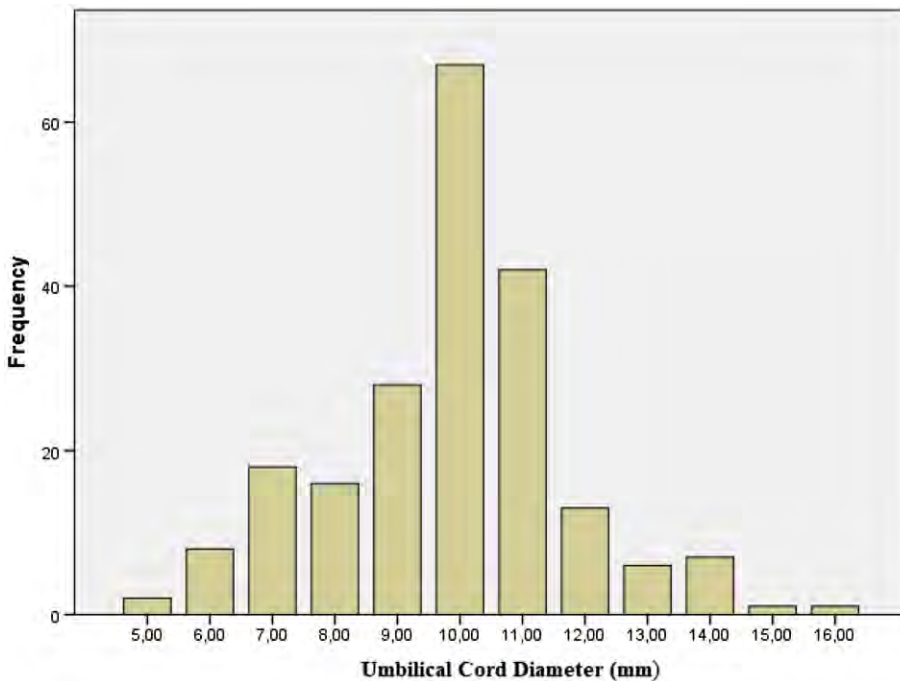


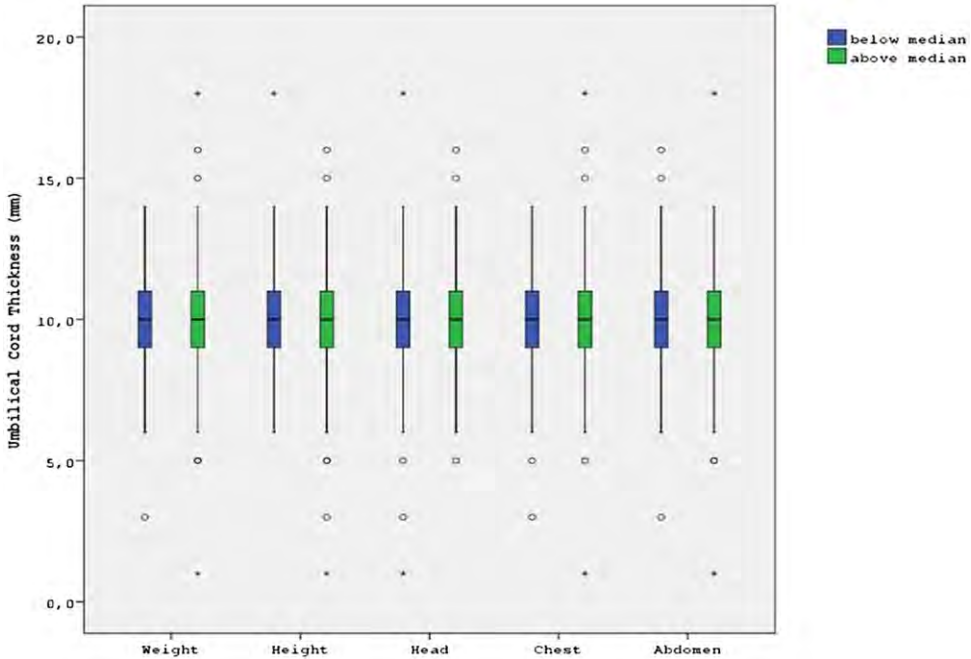
Figure 1. The distribution of the umbilical cord diameter.

Table 2. The correlations between umbilical cord thickness and other birth morphometric parameters.

	Maternal age	Birth weight	Gestational age at birth	Birth height	Head circumference	Chest circumference	Abdominal circumference	Time after birth
Umbilical cord thickness	0.071	0.085	0.034	0.143	0.023	0.049	-0.008	0.016
Correlation coefficient								
Significance	0.308	0.219	0.624	0.039	0.744	0.478	0.907	0.813

Table 3. The differences in umbilical cord diameters regarding gender and birth type.

Parameters		Umbilical cord diameter (mm) Mean (SD) (minimum–maximum)	<i>p</i>
Gender	Male	9.9 ± 1.8 (5–15)	.952
	Female	9.8 ± 1.9 (5–16)	
Birth type	Cesarean section (<i>n</i> = 31)	10.4 ± 2.3 (5–16)	.056
	Vaginal delivery (<i>n</i> = 178)	9.7 ± 1.8 (5–15)	

**Figure 2.** The differences in the umbilical cord diameter in the newborns with lower and higher birth weight, chest circumference, abdominal circumference and head circumference.

the first and second trimesters and reaches a mean of 32 cm at 20 weeks gestation. The male and female cord length reaches to 53.75 cm and 51.75 cm at 34 weeks, respectively (12,13). Short umbilical cords have been associated with low Apgar scores, hypotonia, jitteriness and respiratory problems (13,14).

The morphology and components of the umbilical cord affect birth results (14–16). The length of the umbilical cord is affected by both genetic variations and fetal movements. Increased number of fetal movements is related to a longer cord and vice versa. The shorter umbilical cord is related with/to a less active fetus, fetal malformations, myopathic and neuropathic diseases, Down syndrome and oligohydramnios (14,16,17). Thin umbilical cord can accompany unexplained fetal death, whereas umbilical cord enlargement can be observed in association with fetal hydrops, rhesus sensitization or twin–twin transfusion (18).

The length and diameter of the umbilical cord were shown as 55–60 and 1.5–2.0 cm, respectively (14). In our study, we found umbilical cord diameter as 9.9 (±1.9 SD) mm. Supposing the umbilical cord as a circle, a 9.9 mm diameter means a circumference of

Table 4. Newborns were divided into groups of 4 h intervals, measured from the time of birth, to determine if the umbilical cord diameter decreased due to drying during the first day.

Groups	Time after birth (h)	n	Mean (mm)	SD	Sig.
1	0–4	40	9.93	2.15	
2	5–8	54	9.63	1.82	.98 ^a
3	9–12	43	9.91	1.87	1.00 ^b
4	13–16	16	10.31	1.62	.98 ^c
5	17–20	9	10.00	2.35	1.00 ^d
6	21–24	47	9.81	1.84	1.00 ^e
Total		209	9.94	1.90	

The average value of umbilical cord diameters in each group were measured and compared with each other. Findings show that there is no significant difference in diameters among the groups.

n: number of patients, mean–mean of groups diameters of umbilical cord.

The group 1 was a reference group.

^ap = .98 vs. group 1,

^bp = 1.00 vs. group 1,

^cp = .98 vs. group 1,

^dp = 1.00 vs. group 1,

^ep = 1.00 vs. group 1.

29.1 mm (19,20). After examining a newborn with incidentally diagnosed CHUC, Patel et al. (2) decided to perform a study to assess the normal umbilical cord circumference to be able to detect the newborns with umbilical cord hernia. The authors found umbilical cord circumference as 37.6 ± 7.3 mm and stated that none of the neonates in their study had a cord circumference of 70 mm as seen in the newborns with umbilical cord hernia. Patel et al. (2) reported a progressive increase in umbilical cord circumference with an increase in weight and chest and abdominal circumferences. The authors also stated that an unusually large cord should raise the suspicion of a hernia and the newborn should closely be examined before clamping the cord. In contrast to Patel's study, we found no significant correlation between umbilical cord diameter and birth weight as well as the head, chest, and abdominal circumferences. Interestingly, in this study we found that the umbilical cord thickness increases with the birth height but not with body weight, in contrast to Patel's study (2).

In the literature, there is limited data showing the umbilical cord diameter at birth in newborns. The first study belongs to Patel et al. (2) and the second study is the present study. The situation after clamping of umbilical cord during birth in the newborn; there are few studies about shrinking, drying, and detachment. After clamping, the cord begins to dry and the cord thickness gradually decreases. The period of the complete desiccation of the cord varies from the end of the first day to the fifth day; on the third day it is generally completed (19). For this reason, it is normally expected that there is a negative relationship between the time passed after birth and the thickness of the umbilical cord. In other words, as the time after birth (hour) increases, the thickness of the umbilical cord is expected to decrease. However, in our study, it was determined that there was no meaningful relationship between these two variables during the first 24 h after birth. This indicates that significant desiccation shrinkage is not evident in the first 24 h. As the umbilical cord stump detached between 3 and 45 days, the result of our study is reasonable (21).

In our study, the upper limit of the umbilical cord diameter was 16 mm with a 95% confidence interval limit. Again, supposing the umbilical cord as a circle, this corresponds to a circumference of 30.3 mm. In our study, the highest umbilical cord

diameter measurement was 16 mm, corresponding a circumference of 48mm. According to this study, a circumference above 48 mm should raise suspicion of an umbilical cord hernia and the physicians should be careful not to cause intestinal obstructions in a newborn with CHUC. As mentioned above, Patel et al. (2) stated that the umbilical cord diameter of the newborn with CHUC in their report was 70 mm.

It was reported that CHUC emerges in the early intrauterine life and may be diagnosed in the second trimester by ultrasonography (22,23). The umbilical cord is almost always visible by ultrasound in the first trimester (3). In the first trimester, a significant correlation was reported with gestational age and crown–rump length (24). However, Ince et al. (5) indicated that they could diagnose only six out of 15 cases of CHUC by antenatal ultrasonography. The correlation between umbilical cord parameters and fetal growth was not investigated so far (3).

In this study, we assessed normative umbilical cord diameter measurements at term. Larger studies including the umbilical cord diameters in the newborns with and without CHUC are needed to explore the value of these data in the diagnosis of CHUC.

Disclosure statement

The author declares no conflict of interests.

ORCID

Nazile Ertürk  <http://orcid.org/0000-0001-9541-9741>

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