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Umbilical cord length in singleton gestations: A Finnish population-based retrospective register study

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ABSTRACT

Introduction: Many complications of pregnancy and delivery are associated with umbilical cord length. It is important to examine the variation in length, in order to identify normal and abnormal conditions. Moreover, the factors influencing cord growth and development are not precisely known.
Objective: The main objectives were to provide updated reference charts for umbilical cord length in singleton pregnancies and to evaluate potential factors affecting cord length.
Methods: Birth register data of 47,284 singleton pregnant women delivering in Kuopio University Hospital, Finland was collected prospectively. Gender-specific centile charts for cord length from 22 to 44 gestational weeks were obtained using generalized additive models for location, scale, and shape (GAMLSS). Gestational, fetal, and maternal factors were studied for their potential influence on cord length with single variable analysis and stepwise multiple linear regression analysis.
Results: Cord length increased according to gestational age, while the growth decelerated post-term. Birth weight, placental weight, pregravid maternal body mass index, parity, and maternal age correlated to cord length. Gestational diabetes and previous miscarriages were associated with longer cords, while female gender and placental abruption were associated with shorter cords.
Discussion and conclusions: Girls had shorter cords throughout gestation although there was substantial variation in length in both genders. Cord length associated significantly with birth weight, placental weight, and gestational age. Significantly shorter cords were found in women with placental abruption. This important finding requires further investigation.

1. Introduction

The umbilical cord plays an essential role in intrauterine life. It is the pathway between mother, placenta, and fetus during pregnancy and delivery. In clinical practice, it is well understood that cord length and coiling are related to various prenatal and obstetric complications. However, little is known about the umbilical cord's development.

The variation of the cord length at different gestational ages has been reported in two earlier large-scale studies almost 30 years ago [1,2]. Both were based on data collected from 1959 to 1965 in 13 centers in the USA (National Collaborative Perinatal Project). In these studies, the length correlated to placental weight and increased throughout the pregnancy according to gestational age. Furthermore, the growth rate decreased in the last trimester of pregnancy and the length was different between genders [1]. In a more recent study, based on data from the same Project, associations were shown between cord length and birth weight and the fetoplacental weight ratio [3]. In addition, differences between genders were demonstrated. Smaller studies have not shown any gender-specific differences [4–6].

Other factors which are thought to have an impact on the growth of the umbilical cord include: pregravid maternal weight and height, socioeconomic status, and gestational weight gain [2].

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At present, genetic factors are also expected to have associations with cord length, though differences between races have not been observed [3,7]. From a different perspective, it appears that stretching of the umbilical cord due to uterine or fetal growth, as well as fetal movements, may affect the cord length [8,9]. In this respect, a larger uterus due to fetal macrosomia or polyhydramnios is assumed to be associated with longer cords. This tension theory suggests that the more tension, the longer cord and vice versa [9,10].

In this paper, we provide gender-specific centile charts for cord length from 22 to 44 gestational weeks in singleton pregnancies. We have used routinely collected prospective birth data from 47,284 parturients who delivered in Kuopio University Hospital in Finland since 1989. A large data-base has been maintained in the Kuopio Birth Registry representing a homogenous Finnish population. In addition, we explored a large number of factors that may have an impact on umbilical cord development.

2. Materials and methods

2.1. Study population and data collection

This was an observational retrospective hospital-based register study using data obtained from the Kuopio University Hospital Birth Registry in Finland. All births occurred at the Kuopio University Hospital, which is the tertiary level perinatal center in Central and Eastern Finland, and the only hospital dealing with deliveries in the North Savo district. Since there were no private delivery services in the area, coverage of the general population and representation of all social classes were adequate. During the data collection period (from March 1989 until June 2011) there were no major demographic changes in the hospital's catchment area.

The data was collected from 47,284 women who gave singleton births between 22 and 44 weeks of gestation. Only structurally and chromosomally normal pregnancies were selected, while stillbirths were excluded. Clinical data including information on maternal and neonatal birth characteristics were collected by the teams who took care of each pregnancy or delivery. Written approval for the study was obtained in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) from the Ethics Committee of the Kuopio University Hospital. Only anonymous data was used and therefore, the informed consent of the registered individuals was not needed.

2.2. Gestational age estimation

Estimation of the gestational age was based on the date of the last menstruation, unless there was a discordance of more than 7 days with the first trimester ultrasound or more than 14 days with the second trimester ultrasound. The dating charts showing predicted gestational age by fetal size were derived from previously published charts of fetal measurements [11,12]. In the beginning of the data collection period, gestational age was mainly dated from the last menstruation. This practice has progressively changed as first trimester ultrasound became more common. By 2001, 98% of gestations were being dated with ultrasound measurements. However, the gestational age is seldom changed due to the divergence between the time of amenorrhea and the fetal ultrasound examination. Therefore, the estimation of the gestational age based on the last menstruation was considered accurate.

2.3. Recordings and variable selection

After every delivery (vaginal or Caesarian) umbilical cord length was measured by trained nursing personnel either with a ruler or with a 20 cm long measuring instrument. The segments attached to the neonate and the placenta were also measured, as well as any other parts of the cord that may have been cut out. The lengths were measured to the nearest centimeter and added together in order to get the total cord length. The umbilical cords were clamped and cut after the birth when the pulsation of the umbilical artery was no longer detectable. Only when the neonate required instant neonatal care was the clamping performed immediately after the birth.

Every placenta was routinely examined. Placental weight was measured in grams including umbilical cord and membranes. Placental/fetal weight ratio was calculated as placental weight in grams divided by the weight of neonate in grams $\times 100$. The pregravid maternal body mass index (BMI) was calculated by dividing body weight in kilograms by squared height in meters (kg/m^2). Gestational diabetes mellitus (GDM) was defined by high blood glucose levels in oral 75-g glucose tolerance test (fasting $\geq$ 4.8 mmol/l (until 2008) or $\geq$ 5.3 mmol/l (since 2009), after 1hour $\geq$ 10.0 mmol/l, and after 2hours $\geq$ 8.6 mmol/l) during pregnancy. Diagnosis of velamentous umbilical cord insertion was clinical, as the insertion of the cord was routinely examined by trained nursing personnel. The diagnosis of placenta praevia or placental abruption was performed by clinical examination or with ultrasound as described previously [13,14].

Variables for analysis were chosen based on their potential influence on cord length. These variables were: gestational age, gender, birth weight, birth height, placental weight, placental/fetal weight ratio, maternal age at delivery, marital status, pregravid BMI, parity, pregravid smoking (>5 cigarettes/day), smoking during pregnancy (>5 cigarettes/day), alcohol consumption during pregnancy, self-reported infertility, previous miscarriages, previous abortions, maternal pregravid diabetes mellitus, maternal chronic disease, GDM, preeclampsia, velamentous cord insertion, placenta praevia, and placental abruption.

2.4. Centile charts and statistical analysis

Generalized Additive Models for Location, Scale, and Shape (GAMLSS) were used in the construction of centile charts of cord length, and cubic splines for smoothing

Table 1
Parameters and percentile values of umbilical cord length (cm) for girls (g) (n = 23,148) and boys (b) (n = 24,136) in different gestational ages.

Gestational age (weeks)	Number of cases (g/b)	10th centile (g/b)	50th Centile, M[a] (g/b)	90th centile (g/b)	S[b] (g/b)	L[c] (g/b)
22	4/8	22.9/24.6	33.3/34.6	48.7/48.6	0.29/0.26	−0.05/−0.02
23	9/13	23.7/25.3	34.3/35.5	49.7/50.1	0.29/0.27	−0.02/−0.03
24	21/12	24.6/25.9	35.3/36.5	50.7/51.7	0.28/0.27	0.02/−0.03
25	26/19	25.4/26.5	36.3/37.5	51.7/53.2	0.28/0.27	0.05/−0.04
26	30/36	26.2/27.3	37.3/38.5	52.6/54.7	0.27/0.27	0.09/−0.05
27	47/37	27.0/28.0	38.3/39.6	53.6/56.2	0.27/0.27	0.12/−0.05
28	42/41	27.8/29.0	39.4/40.8	54.8/57.7	0.26/0.27	0.15/−0.05
29	32/37	28.8/30.0	40.6/42.1	56.2/59.3	0.26/0.27	0.17/−0.05
30	35/55	29.8/31.2	41.9/43.5	57.7/60.9	0.26/0.26	0.19/−0.05
31	47/54	30.9/32.6	43.4/45.1	59.4/62.6	0.25/0.25	0.21/−0.04
32	80/82	32.1/34.1	44.9/46.8	61.2/64.5	0.25/0.25	0.23/−0.03
33	90/114	33.4/35.7	46.5/48.6	63.0/66.4	0.25/0.24	0.25/−0.01
34	127/181	34.7/37.3	48.1/50.5	65.0/68.4	0.24/0.24	0.26/0.01
35	228/276	36.1/38.9	49.8/52.5	66.9/70.5	0.24/0.23	0.28/0.04
36	446/551	37.7/40.5	51.6/54.3	68.9/72.4	0.23/0.23	0.28/0.07
37	928/1113	39.3/41.9	53.3/55.9	70.7/74.1	0.23/0.22	0.27/0.1
38	2769/3110	40.8/43.1	54.8/57.3	72.2/75.5	0.22/0.22	0.24/0.12
39	5733/6028	42.3/44.5	56.3/58.8	73.7/77.0	0.22/0.21	0.19/0.12
40	6662/6814	43.8/45.7	57.7/60.1	75.3/78.5	0.21/0.21	0.14/0.1
41	4580/4364	44.9/46.4	58.9/60.9	76.8/79.6	0.21/0.21	0.1/0.07
42	1145/1162	45.7/46.5	59.7/61.2	77.8/80.1	0.21/0.21	0.06/0.04
43	61/57	46.4/46.5	60.5/61.2	78.6/80.5	0.21/0.21	0.03/0.01
44	6/2	46.8/46.4	60.9/61.2	79.1/80.7	0.20/0.22	0.01/−0.01

[a] Median.
[b] Coefficient of variation.
[c] Box-Cox transformation power.