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Short umbilical cord length: reflective of adverse pregnancy outcomes

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Summary

A short umbilical cord is associated with adverse pregnancy outcomes. However, there is no universally accepted definition of a short cord. *Objective:* This study aimed to determine the umbilical cord length showing the highest correlation with adverse pregnancy outcomes. *Materials and Methods:* The authors retrospectively analyzed the clinical data of women who attempted vaginal birth in the present institution. Umbilical cord lengths were categorized into three groups: less than the first percentile, from the first percentile to less than the tenth percentile, and others. Maternal and neonatal characteristics previously suggested to affect cord length were evaluated. The main outcome was the rate of cesarean delivery. The authors also evaluated the frequency of operative vaginal delivery, small-for-gestational-age (SGA) births, neonatal intensive care unit (NICU) admission, umbilical artery pH < 7.1, and abnormal bleeding during delivery. *Results:* Cord lengths of 35 and 45 cm corresponded to the first and tenth percentiles, respectively. A short cord was an indicator of unplanned cesarean delivery and small-for-gestational-age births. *Conclusion:* An umbilical cord length of ≤45 cm is a clinically useful indicator of adverse pregnancy outcomes.

Key words: Umbilical cord; Pregnancy outcome; Cesarean delivery rate.

Introduction

The presence of a short umbilical cord has been linked to adverse pregnancy outcomes. There have been reports that relate short cords with increased risk for retained placenta, placental abruption, operative delivery, and non-reassuring fetal status (NRFS) [1,2]. One study demonstrated that short umbilical cord defined as < 40 cm in length was present in only 6% of term births, and its presence was associated with subsequent childhood mental and motor impairments [3]. In another study, specific fetal heart rate patterns were observed in babies with cords shorter than 35 cm [4]. However, there is currently no universally accepted definition of short umbilical cord. Thus it is not clear which length best correlates with poor pregnancy outcomes. Moreover, many of the previous studies on the link between pregnancy outcomes and the presence of a short cord were conducted in Europe and North America, and data is limited for other ethnic groups. Therefore, the objective of this study was to determine the length of umbilical cord that shows the highest correlation with adverse pregnancy outcomes in a Japanese population. To this end, the authors analyzed data of term singleton pregnancies in which vaginal birth was attempted using the rate of cesarean delivery as the main outcome. They also evaluated adverse outcomes which are considered to be related to umbilical cord length.

Materials and Methods

The authors conducted a retrospective analysis of the medical records of women who attempted vaginal birth and delivered singletons in the Perinatal Center for Maternity and Neonates at Yokohama City University Medical Center between January 2001 and July 2014. The exclusion criteria were preterm birth, multiple gestations, noncephalic presentation, a history of uterine operation, obvious fetal structural abnormalities diagnosed during pregnancy, and elective cesarean delivery owing to maternal complications. This study was approved by the ethics committee of the Yokohama City University Medical Center.

The main outcome of this study was the rate of cesarean delivery. The authors also evaluated the frequency of operative vaginal delivery, small-for-gestational-age (SGA) infants, neonatal intensive care unit (NICU) admission, umbilical artery pH < 7.1, and abnormal bleeding during delivery. SGA was defined as the lower tenth percentile of birth weight for gestational age, as defined by the Japanese Ministry of Health, Labour and Welfare. Abnormal bleeding during delivery was defined as a blood loss of ≥ 500 ml for vaginal delivery and of ≥ 1,000 ml for cesarean delivery. When neonatal resuscitation was necessary, a neonatologist was called and asked whether NICU admission was indicated.

The authors analyzed the umbilical cord lengths and categorized them into three groups: less than the first percentile, from the first percentile to less than the tenth percentile, and others (control group). The three cord length groups were compared in terms of pregnancy outcomes. Maternal and neonatal characteristics previously suggested to affect cord length, including parity, maternal body mass index (BMI) at the time of birth, maternal age, neonatal sex, and neonatal birth weight, were evaluated among the three

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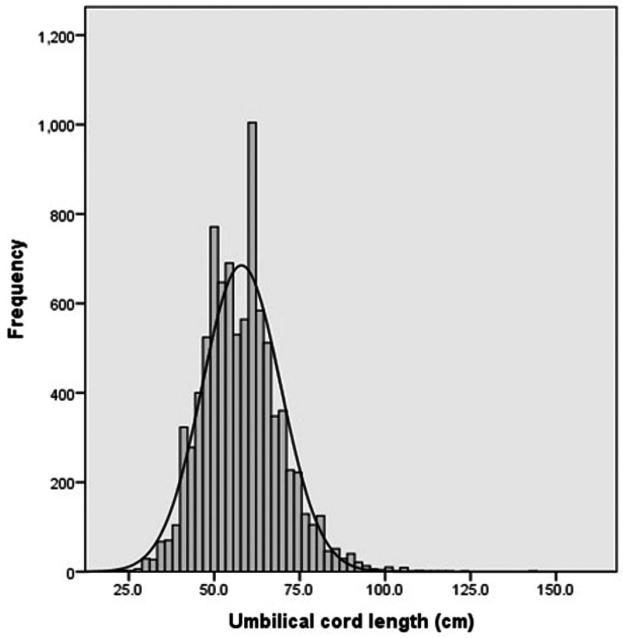

Figure 1. — Distribution of umbilical cord length in the study population.

groups.

Data were expressed as means ± standard deviation or frequencies (percentages). The SPSS Statistics program version 19 was used for the statistical analyses. Pearson's chi-square test was performed to determine the significance of differences of outcomes between cord length of ≤ 35 cm and control, and > 35 to ≤ 45 cm, and control with Bonferroni correction for multiple comparisons. A p value of < 0.05 was considered statistically significant. Bonferroni method was used to correct p values. Logistic regression analysis was performed used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) adjusting for confounding variables. The obtained results were expressed as ORs and 95% CIs.

Results

During the observation period, there were 13,486 deliveries. Of these, 9226 deliveries met the study criteria. The authors excluded cases with inadequate data, and 8,892 cases were included in the analysis. The distribution of the umbilical cord lengths is shown in Figure 1. The average cord length was 58.0 cm, and the lengths of 35 cm and 44.3 cm corresponded to the first and tenth percentile values of the cord length distribution, respectively. For the sake of simplification, the authors considered a length of 45 cm as the tenth percentile. The maternal and neonatal characteristics in the short cord and control groups are shown in Table 1. The short cord groups had a higher rate of primiparity (p < 0.001), higher incidence of female babies (p < 0.001), lower BMI (p < 0.001), lower birth weight (p < 0.001), and shorter period of gestation (p < 0.001) than the control group.

Table 1. — *Maternal and neonatal characteristics in the three cord length groups.*

Cord length (cm)	n=133 ≤ 35	n=1045 >35, ≤ 45	n=7714 > 45	p value
Maternal age	31.1±5.5	31.5±5.2	31.6±5.1	0.3
Maternal BMI[a] (kg/m^2)	24.7±4.1	24.5±3.1	25.1±3.2	<0.001*
Gestational period (weeks)	39.2±1.2	39.4±1.1	39.6±1.0	<0.001*
Neonatal birth weight (g)	2805±425	2940±386	3065±375	<0.001*
Parity (primi)	63.20%	59.00%	53.10%	<0.001*
Sex of the neonate (male)	45.10%	44.30%	52.50%	<0.001*

[a] Body mass index. *Statistical significance p < 0.05.

Table 2. — *Incidence of adverse pregnancy outcomes. Comparison between control and length ≤ 35 cm.*

Cord length (cm)	n=133 ≤35	n=7714 >45	p value
Cesarean delivery	16 (12%)	441 (5.7%)	0.004*
Operative vaginal delivery	8 (6%)	441 (5.7%)	1
Small for gestational age	27 (20.3%)	709 (9.2%)	<0.001*
NICU[a] admission	19 (14.3%)	565 (7.3%)	0.002*
Umbilical artery pH <7.1	3 (2.3%)	98 (1.3%)	0.64
Abnormal bleeding (within vaginal delivery)	24 (20.5%)	1871 (25.7%)	0.4
Abnormal bleeding (within cesarean delivery)	0 (0%)	85 (19.2%)	0.1

[a] Neonatal intensive care unit. *Statistical significance p < 0.05.

Table 3. — *Incidence of adverse pregnancy outcomes. Comparison between control and > 35cm, ≤ 45cm.*

Cord length (cm)	n=1045 >35, ≤ 45	n=7714 > 45	p value
Cesarean delivery	120 (11.5%)	441 (5.7%)	<0.001*
Operative vaginal delivery	52 (5%)	441 (5.7%)	0.66
Small for gestational age	144 (13.8%)	709 (9.2%)	<0.001*
NICU[a] admission	70 (6.7%)	565 (7.3%)	0.93
Umbilical artery pH <7.1	12 (1.1%)	98 (1.3%)	1
Abnormal bleeding (within vaginal delivery)	191 (20.6%)	1871 (25.7%)	0.002*
Abnormal bleeding (within cesarean delivery)	21 (17.5%)	85 (19.2%)	1

[a] Neonatal intensive care unit. *Statistical significance p < 0.05.

Comparisons of pregnancy outcomes between the two short cord length groups and control group are shown in Tables 2 and 3. Statistically significant differences in the rate of cesarean delivery, SGA births, and NICU admission were observed between the ≤ 35-cm cord length group and control group (Table 2). Moreover, statistically significant differences in the rate of cesarean delivery, SGA births, and abnormal bleeding during vaginal delivery were observed between the > 35- to ≤ 45-cm cord length group and control group (Table 3). The authors performed a logistic regression analysis of each outcome

Table 4. — *Logistic regression analysis on adverse pregnancy outcomes.*

	OR	95% CI	*p* value
Cesarean delivery			
≤35	2.08	1.17−3.69	0.02*
>35, ≤ 45	2.31	1.85−2.90	<0.001*
>45	Ref		
SGA[a] infant			
≤35	2.47	1.58−3.85	<0.001*
>35, ≤ 45	1.54	1.26−1.87	<0.001*
>45	Ref		
NICU[b] admission			
≤35	1.75	1.06−2.89	0.03*
>35, ≤ 45	0.83	0.64−1.08	0.17
>45	Ref		
Abnormal vaginal bleeding			
≤35	0.98	0.61−1.58	0.93
>35, ≤ 45	0.85	0.71−1.01	0.07
>45	Ref		

[a] Small for gestational age; [b] neonatal intensive care unit; *Statistical significance $p < 0.05$.
Adjusted variables: Maternal age, parity, gestational age, maternal body mass index, sex of neonate, and birthweight of neonate (birthweight of neonate was excluded as variable for SGA).

with statistically significant differences among groups (Table 4). The presence of a short cord was an indicator of higher rates of cesarean delivery (≤ 35-cm group: OR = 2.08, 95% CI = 1.17–3.69; > 35- to ≤ 45-cm group: OR = 2.31, 95% CI = 1.85–2.90) and SGA births (≤ 35-cm group: OR = 2.47, 95% CI = 1.58–3.85; > 35- to ≤ 45-cm group: OR = 1.54, 95% CI = 1.26–1.87); furthermore, the rate of NICU admission was higher in patients with cord lengths of ≤ 35 cm (OR = 1.75, 95% CI = 1.06–2.89). The logistic regression analysis showed no statistically significant differences in the rate of abnormal bleeding during vaginal delivery among the groups.

Discussion

In this study, the authors found that a short umbilical cord was associated with adverse pregnancy outcomes. The rate of unplanned cesarean delivery nearly doubled in patients with cord lengths of ≤ 35 and ≤ 45 cm, which corresponded to the first and tenth percentile values of the cord length distribution, respectively. Moreover, they found that the frequencies of SGA births and NICU admission were higher in women with shorter cords. In addition, they showed that factors such as female sex of the fetus, primiparity, lower maternal BMI, and lower neonatal birth weight were associated with shorter cord lengths.

With respect to characteristics that reflect the cord length, the present results are generally consistent with those of previous studies that investigated the relationship between cord length and pregnancy outcomes. In a large population study conducted in Finland, shorter cords were associated with low-birth-weight infants, primiparity, female neonates, and advanced maternal age [2]. A population-based retrospective study using the Washington State Birth Events Records Database showed that women with short-cord infants are less likely to be overweight and more likely to be primiparous and to give birth to female infants [1].

The main outcome of the present study was the rate of cesarean delivery. This study demonstrated that the incidence of cesarean delivery increased in the short cord groups. However, previous studies have shown conflicting results. Sornes [5] observed a higher incidence of cesarean delivery in patients with cord lengths of < 46 cm, whereas Krakowiak *et al*. [1] observed a 50% decrease in the rate of cesarean delivery and an increase in the rate of vacuum and forceps delivery in the short cord group. In a study by Krakowiak et al. [1], a short cord was identified not by the absolute length of the umbilical cord but by the International Classification of Diseases ninth revision codes. Thus, the results of this study may not be comparable with those of our study. Berg et al. [6] observed no differences in the cesarean delivery rate according to cord length, but the relatively small sample size (n = 3019) may have affected the results. Most studies agree that a short cord is associated with an increased risk of NRFS [4,5,7]. Differences in the indications for cesarean delivery and operative vaginal delivery may have contributed to the varied results among studies.

In our study, the presence of a short cord was associated with a higher likelihood of SGA infants and NICU admission but was not associated with acidemia. Previous studies on umbilical cord length have reported that a short cord is associated with poor fetal and neonatal prognosis. Krakowiak *et al*. [1] reported that SGA births, hypoxic-ischemic encephalopathy, NRFS, and infant death were associated with short cords. Berg *et al*. [6] stated that the acid-base balance of the umbilical artery is not affected by cord length and speculated that outcomes in fetuses and neonates with short cords are affected not by stress during delivery but by developmental conditions before labor. Therefore, it is necessary to determine whether a short umbilical cord affects the condition of the fetus during delivery or is an indicator of an unfavorable condition of the fetus in the uterus.

To understand the mechanism underlying the association between short umbilical cords and poor pregnancy and neonatal outcomes, factors that accelerate umbilical cord growth were investigated. It has been generally accepted that umbilical cord growth is activated by tension applied to the cord [8]. This so-called “stretch hypothesis” was proposed by Miller *et al*. on the basis of the observation that cord growth is accelerated during the second trimester when fetal activity and amniotic fluid level are at their highest during pregnancy [9, 10]. Moreover, studies using animal models have suggested that exposure to substances that

decrease fetal movement in the uterus, such as atenolol, ethanol, and curare, is associated with short cords [11, 12]. However, recently, evidence against this theory has been presented, suggesting that the umbilical cord grows linearly during gestation [2, 13].

Studies conducted to date have used various definitions of short cord length. Most studies on umbilical cord length report the average cord length to be approximately 55–65 cm for term deliveries [2, 7, 14-16]. In the present study in a Japanese population, the average cord length was 58.0 cm, and 35cm and 45 cm corresponded to the first and tenth percentile values of the cord length distribution, respectively. One study defined a short cord as < 40 cm in length on the basis of the fact that it is the lower sixth percentile in term births and its presence was associated with subsequent childhood mental and motor impairments [3]. In another study, a short cord was defined as < 35 cm in length, and specific fetal heart rate patterns were observed in patients with short cords [4]. The present study demonstrated that a cord length of ≤ 45 cm was associated with an increased risk of cesarean delivery and SGA births. Moreover, the authors showed that it corresponded to the lower tenth percentile in term deliveries and they consider this length to be both statistically and clinically appropriate.

This study has some limitations including the small sample size and the fact that it was performed at a single tertiary center and could be subject to selection bias. A population-based analysis with a larger sample size may be necessary to clarify the mechanisms responsible for the adverse outcomes associated with the presence of a short umbilical cord.

Conclusion

Short umbilical cord is associated with adverse pregnancy outcomes, such as an increased incidence of cesarean deliveries and SGA infants. Moreover, the authors suggest that a length of ≤ 45 cm, corresponding to the tenth percentile value of the cord length distribution, is an appropriate definition of a short umbilical cord, which is associated with adverse pregnancy outcomes.

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