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Length of the Umbilical Cord and Perinatal Outcomes in Japanese Singleton Pregnancies Delivered at Greater Than or Equal to 34 Weeks' Gestation

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Abstract

Background: We examined the relation between the length of the umbilical cord and perinatal outcomes in Japanese singleton pregnancies delivered at ≥ 34 weeks' gestation.

Methods: The material reviewed consisted of the total population of Japanese women who gave birth to singleton babies at 34 - 41 weeks' gestation at Japanese Red Cross Katsushika Maternity Hospital between 2002 and 2009.

Results: The average of the length of the umbilical cord was 56.2 ± 11.7 cm (range: 19 - 133 cm). Long and short umbilical cords were defined as those umbilical cords measuring approximately + 1.5 SD above and -1.5 SD below the mean, which are ≥ 74 and ≤ 38 cm in length (5.0 and 0.9 %). Normal umbilical cords were defined as those umbilical cords measuring within ± 1.0 SD of the mean, which is 45 - 68 cm in length. Using logistic multivariable regression analysis, short umbilical cords were associated with the increased rate of emergent Cesarean delivery (adjusted OR 2.20, 95% CI 1.3 - 3.7, P < 0.01) while the long umbilical cords were associated with the increased rate of multiple nuchal cords and true umbilical knots (multiple nuchal cords: adjusted OR 9.16, 95% CI 7.4 - 11, P < 0.01; true umbilical knots: adjusted OR 8.95, 95% CI 5.1 - 16, P < 0.01). However they were not associated significantly with the adverse perinatal outcomes.

Conclusions: The short or long umbilical cords may not be associated with the adverse perinatal outcomes in Japanese singleton pregnancies delivered at ≥ 34 weeks' gestation.

Keywords: Short umbilical cords; Long umbilical cords; Perinatal outcome; Japanese pregnancy

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Introduction

Most umbilical cords have been reported to be 50 - 60 cm, and very few have been observed to be abnormally short or long [1, 2]. To date, some authors have agreed that excessively short and long umbilical cords have been suggested to correlate with a variety of fetal problems such as intrapartum distress and/or demise [1-6], while some authors have denied any relation to fetal distress and poor fetal outcome from problems of umbilical cord length in their literatures [7-9]. In this study, we examined the relation between the length of the umbilical cord and perinatal outcomes in Japanese singleton pregnancies delivered at ≥ 34 weeks' gestation.

Methods

The protocol for this study was approved by the Ethics Committee of Japanese Red Cross Katsushika Maternity Hospital. Informed consent concerning analysis from a retrospective database was obtained from all subjects.

The material reviewed consisted of the total population of Japanese women who gave birth to singleton babies at 34 - 41 weeks' gestation at Japanese Red Cross Katsushika Maternity Hospital between 2002 and 2009. All umbilical cords and placentae were screened identically by trained staff.

During this period, there were 11,029 Japanese women who gave birth to singleton babies at 34 - 41 weeks' gestation. Table 1 shoes the clinical characteristics and findings of placentae of the patients. The average of the length of the umbilical cord was 56.2 ± 11.7 cm (range: 19 - 133 cm). In this study, long umbilical cords were defined as those umbilical cords measuring approximately +1.5 SD above the mean, which is ≥ 74 cm in length (n = 548, 5.0%), while short umbilical cords were defined as those umbilical cords measuring approximately -1.5 SD below the mean, which is ≤ 38 cm in length (n = 96, 0.9%). In this study, normal umbilical cords were defined as those umbilical cords mea-

Table 1. Clinical Characteristics and Findings of Placentae of the Japanese Women who Gave Birth to Singleton Babies at 34 - 41 weeks' Gestation

Numbers	11,029
Maternal age (years)	32.8 ± 5.2
Nulliparity	5,121 (46.4)
Gestational age at delivery (weeks)	38.5 ± 1.5
Neonatal birth weight (g)	3,024 ± 413
Umbilical cord length (cm)	56.2 ± 11.7
Placental weight (g)	589 ± 114

suring within ± 1.0 SD of the mean, which is 45 - 68 cm in length (n = 9,809).

The diagnosis of circumvallate placenta, succenturiate lobes of placenta, velamentous cord insertion and single umbilical artery were made macroscopically and confirmed by placental pathology. The gestational age of the pregnancies were established by ultrasonographic examination of the fetal crown-rump length at 8 - 11 weeks' gestation.

Light for gestational age and heavy for gestational age infants were defined as those with sex- and aged-adjusted birth weights below and over the tenth percentile according to the fetal growth curve for Japanese (Acta Neonatol Jpn from Japan Society of Neonatology, 1998). Oligohydramnios was defined as an amniotic fluid index value < 5, while polyhydramnios was defined as an amniotic fluid index value > 24 on ultrasonographic examination during pregnancy. Non-reassuring fetal status was diagnosed using fetal cardiotocogram based on ACOG Committee Opinion (2004). Apgar scores < 7 were considered low. Placental abruption was defined as complete or partial separation of a normally implanted placenta occurring before delivery, confirmed at delivery by evidence of retro-placental bleeding at delivery and placental pathology. Hypertensive disorders were defined as blood pressure > 140/90 mmHg measured on two or more occasions at least 6 hours apart with the patient under bed rest. A 75 g 2 hour oral glucose tolerance test was performed to diagnose gestational diabetes according to the Japan Society of Obstetrics and Gynecology (1995). During this period, gestational diabetes was defined as following three criteria: a plasma glucose level that met two of the ≥ 100 mg/dL while fasting, ≥ 180 mg/dL at 1 hour, or ≥ 150 mg/dL at 2 hours.

Data are presented as mean ± standard deviation (SD) or number (%). For statistical analysis, the X^2 test for categorical variables and the Student's t-test for continuous variables were used. Differences with $P < 0.05$ were considered significant. Crude odds ratios (ORs) and 95% confidence intervals (CIs) were also calculated. Variables used in the multivariate model were those that on univariate analysis had shown statistically significance ($P < 0.05$) toward association with clinical significance in pregnancies with short and long umbilical cords. Logistic regression was then performed to identify the independent factors associated with the length in a multivariate model.

Results

Table 2 shows the clinical characteristics of the Japanese singleton pregnancies delivered at 34 - 41 weeks' gestation with normal, short and long umbilical cords. There were no measurable differences in maternal age, parity or maternal complications such as hypertensive disorders or gestational diabetes among the 3 groups.

In the both pregnancies with short and long umbilical cords, the rate of pregnancies conceived in vitro fertilization was significantly higher than that with normal umbilical cords (short umbilical cords: crude OR 16.0, 95% CI 7.7 - 33, $P < 0.01$; long umbilical cords: crude OR 5.56, 95% CI 3.3 - 9.4, $P < 0.01$).

Table 3 shows the perinatal outcomes in the Japanese singleton pregnancies delivered at 34 - 41 weeks' gestation with normal, short and long umbilical cords.

In the pregnancies with short umbilical cords, the rate of emergent Cesarean delivery was significantly higher (crude OR 1.94, 95% CI 1.2 - 3.2, $P < 0.01$) and the rate of heavy-for-gestational-age infant was significantly lower (crude OR 0.00, $P = 0.02$) than those with normal umbilical cords. The average neonatal birth weight and placental weight in the pregnancies with short umbilical cords were significantly lighter than those with normal umbilical cords. Using logistic multivariable regression analysis, short umbilical cords were associated with the increased rate of emergent Cesarean delivery (adjusted OR 2.20, 95% CI 1.3 - 3.7, $P < 0.01$)

Table 2. Clinical Characteristics of the Japanese Singleton Pregnancies Delivered at 34 - 41 Weeks' Gestation With Normal, Short and Long Umbilical Cords

	Normal umbilical cord	Short umbilical cord	P value	Long umbilical cord	P value
(Length of umbilical cord)	(45 - 68 cm)	(19 - 38 cm)		(74 - 133 cm)	
Numbers	9809	96		548	
Maternal age					
Average (years)	32.8 ± 5.3	32.1 ± 4.8	0.16	32.9 ± 4.6	0.21
< 20 years	151 (1.5)	0 (0)	0.22	6 (1.1)	0.41
≥ 35 years	2438 (24.9)	32 (33.3)	0.08	151 (27.6)	0.16
Nulliparity	5099 (52.0)	46 (47.9)	0.43	277 (50.5)	0.51
History of in vitro fertilization use	63 (0.6)	9 (9.4)	< 0.01	19 (3.5)	< 0.01
Maternal complications					
Hypertensive disorders	182 (1.9)	4 (4.2)	0.1	14 (2.6)	0.24
Geatstional diabetes	34 (0.3)	1 (1.0)	0.25	4 (0.7)	0.15

Data are presented as number (%) or mean ± SD. P-value vs. normal umbilical cords group by the X^2 test or the Student's t-test.

Table 3. Perinatal Outcomes of the Japanese Singleton Pregnancies Delivered at 34 - 41 Weeks' Gestation With Normal, Short and Long Umbilical Cords

	Normal umbilical cord	Short umbilical cord	P value	Long umbilical cord	P value
(Length of umbilical cord)	(45 - 68 cm)	(19 - 38 cm)		(74 - 133 cm)	
Numbers	9,809	96		548	
Gestational age at delivery (weeks)	38.1 ± 2.6	37.8 ± 2.4	0.23	37.9 ± 2.5	0.11
Perinatal complications					
Oligohydramnios	158 (1.6)	1 (1.0)	0.66	11 (2.0)	0.48
Polyhydramnios	23 (0.2)	0 (0)	0.63	1 (0.2)	0.81
Non-reassuring fetal status	363 (3.7)	3 (3.1)	0.77	27 (4.9)	0.14
Placental abruption	73 (0.7)	1 (1.0)	0.74	2 (0.4)	0.31
Intrauterine fetal death	5 (0.1)	0 (0)	0.82	0 (0)	0.6
Placental weight (g)	590 ± 99	492 ± 115	< 0.01	672 ± 108	< 0.01
Abnormal placenta/umbilical cord					
Placenta previa	81 (0.8)	0 (0)	0.37	3 (0.5)	0.48
Circumvallate placenta	129 (1.3)	2 (2.1)	0.51	11 (2.0)	0.17
Succenturiate lobes of placenta	67 (0.7)	0 (0)	0.42	9 (1.6)	0.01
Velamentous cord insertion	93 (0.9)	1 (1.0)	0.93	5 (0.9)	0.93
Single umbilical artery	12 (0.1)	0 (0)	0.73	2 (0.4)	0.13
Nuchal cord ≥ 2 times	311 (3.2)	0 (0)	0.08	157 (28.6)	< 0.01
True umbilical knots	31 (0.3)	0 (0)	0.58	21 (3.8)	< 0.01
Prolapse/fore-lying of the cord	13 (0.1)	0 (0)	0.72	2 (0.4)	0.16
Delivery mode					
Vacuum/forceps	661 (6.7)	8 (8.3)	0.54	51 (9.3)	0.43
Elective Cesarean	811 (8.3)	7 (17.7)	0.73	33 (6.0)	0.06
Emergent Cesarean	1,107 (11.3)	19 (19.8)	< 0.01	37 (6.8)	< 0.01
Neonatal outcome					
Neonatal birth weight (g)	3,032 ± 468	2,668 ± 550	< 0.01	3,018 ± 447	0.28
Light for gestational age	846 (3.6)	12 (12.2)	0.18	42 (7.7)	0.43
Heavy for gestational age	545 (5.6)	0 (0)	0.02	41 (7.5)	0.06
Apgar score < 7 (1 min)	142 (1.4)	1 (1.0)	0.74	14 (2.6)	0.04
Apgar score < 7 (5 min)	26 (0.3)	0 (0)	0.01	1 (0.2)	0.71
Chromosomal aberration	6 (0.1)	0 (0)	0.81	1 (0.2)	0.29
Postpartum hemorrhage ≥ 1,000 mL	397 (4.0)	6 (6.3)	0.28	36 (6.6)	< 0.01

Data are presented as number (%) or mean ± SD. P-value vs. normal umbilical cords group by the X^2 test or the Student's t-test.

Table 4. Adjusted Odds Ratios and 95% Confidence Intervals in Cases With Long Umbilical Cords Using Logistic Multivariable Regression Analysis

	P value	Adjusted OR (95% CI)
Abnormal placenta/umbilical cord		
Succenturiate lobes of placenta	0.11	1.74 (0.87 - 3.5)
Nuchal cord ≥ 2 times	< 0.01	9.16 (7.4 - 11)
True umbilical knots	< 0.01	8.95 (5.1 - 16)
Vacuum/forceps delivery	0.16	1.24 (0.92 - 1.7)
Emergent Cesarean delivery	0.08	0.74 (0.53 - 1.0)
Neonatal Apgar score < 7 (1 min)	0.14	1.51 (0.87 - 2.6)

OR, odds ratio; CI, confidence interval.

although they did not show an independent relation with the rate of heavy-for-gestational-age infant (P = 0.06).

In the pregnancies with long umbilical cords, the incidence of pregnancies with succenturiate lobes of placenta, multiple nuchal cords and true umbilical knots were significantly higher than those with normal umbilical cords (succenturiate lobes of placenta: crude OR 2.43, 95% CI 1.2 - 4.9, P = 0.01; multiple nuchal cords: crude OR 12.3, 95% CI 9.9 - 15, P < 0.01; true umbilical knots: crude OR 12.6, 95% CI 7.2 - 22, P < 0.01). Although the rate of emergent Cesarean delivery was lower in the pregnancies with long umbilical cords than that with normal umbilical cord (crude OR 0.57, 95% CI 0.41 - 0.80, P < 0.01), the rate of vacuum/forcepsdeliveries was higher (crude OR 1.42, 95% CI 1.1 - 1.9, P = 0.02). The average neonatal birth weight and placental weight in the pregnancies with long umbilical cords were significantly heavier than those with normal umbilical cords. In the pregnancies with long umbilical cords, in addition, the rate of low Apgar score at 1 minute and postpartum hemorrhage ≥ 1,000 mL were significantly higher than those with normal umbilical cords (low Apgar score at 1 minute: crude OR 1.78, 95% CI 1.0 - 3.1, P = 0.04; postpartum hemorrhage ≥ 1,000 mL: crude OR 1.67, 95% CI 1.2 - 2.4, P < 0.01).

Using logistic multivariable regression analysis, the long umbilical cords were associated with the increased rate of multiple nuchal cords and true umbilical knots; however they were not associated significantly with the adverse perinatal outcomes as shown in Table 4.

Discussion

The major findings of this study were as follows: (1) the occurrence of abnormal length of the umbilical cords seemed to be increased in the pregnancies conceived in vitro fertilization; (2) the short umbilical cords seemed to contribute to the increased rate of emergent Cesarean delivery; however they may not be associated with adverse perinatal outcomes; and (3) the long umbilical cords seemed to be associated with the increased rate of multiple nuchal cords and true knots; however they may not contribute to adverse perinatal outcomes.

This may be the first report indicating the relation between the length of the umbilical cords and the history of in vitro fertilization use. However, mechanisms leading to this consequence are not clear. A relationship between the placental morphologic features and the superficial implantation and/or inadequate orientation of the blastocyst after in vitro fertilization and intrauterine embryo transfer has been proposed [10]. In addition, an abnormal insertion of the cord is of major clinical importance because of its association with vasa praevia and fetal haemorrhage has been thought to be caused by disturbed orientation of the blastocyst at implantation which is probably related to the in vitro fertilization and embryo transfer procedure [11]. In this study, we could not find these placental abnormalities in the pregnancies with short or long umbilical cords; however the characteristic implantation and/or orientation of embryo conceived in vitro fertilization may contribute to the abnormal length of the umbilical cords.

In this study, although the short umbilical cords seemed to contribute to the increased rate of emergent Cesarean delivery, they may not be associated with adverse perinatal outcomes. Logically the unentangled cord length must reach from the placental insertion to the vaginal outlet if the infant is to be delivered without complications [1-3]. Situations in which less cord remains in the uterine cavity may have the

potential to prevent the fetal descending during labor, which may also contribute to the increased rate of emergent Cesarean section without fetal asphyxia. These results seem to support a previous study by Berg and Rayburn [7] that an abnormally short umbilical cord at birth beyond 34 weeks is not by itself associated with an increased risk of acid-base imbalance at delivery; however they may contrary to some previous reports concerning the increased risk of mothers and fetuses with short umbilical cords [1-6]. One reason for the differences may be a small sample size in this study. In our study, there were only 96 pregnancies complicated by short umbilical cord. The other reason may be the study with the singleton pregnant women who delivered at ≥ 34 weeks' gestation. We think that almost serious cases such as severe fetal growth restriction and/or congenital anomalies in our institute have been intervened before 34 weeks' gestation.

In this study, the long umbilical cords seemed to be associated with the increased rate of multiple nuchal cords and true umbilical knots. Although multiple nuchal cords and true umbilical knots have been reported to be associated with fetal and/or neonatal asphyxia and/or demise [12, 13]; in this study, however long umbilical cords did not contribute to adverse perinatal outcomes by themselves. In theory, fetal movement produces a tension on the cord that creates ample free length for delivery plus the length of the wrapped cord [3]. Although an entangled cord may be at risk for intermittent or partial occlusion of umbilical blood flow as previously reported [12, 13], the excessively long cord may have self-protective effects to protect the fetuses from the risk of decreasing umbilical blood flow.

At last, in this study, the length of umbilical cords seemed to be related to placental (and infant) weight. An earlier Nigerian study of 602 cord lengths measured in labor and delivery had found a mean length of 57.5 cm, and had also found a correlation of length with infant and placental weight [13]. While, another early British study of 177 infants measured a mean cord length of 61 cm, the length did not correlate with infant or placental weight [14]. We cannot explain well the association between the length of umbilical cord and in vitro fertilization that mentioned above; however the current results may support the former report [15] that the growth umbilical cord is influenced by placental and/or fetal developments.

In conclusions, the short umbilical cords seemed to contribute to the increased rate of emergent Cesarean delivery, while the long umbilical cords seemed to contribute to the increased rate of multiple nuchal cords and true knots. However, the short or long umbilical cords may not be associated with the adverse perinatal outcomes in Japanese singleton pregnancies delivered at ≥ 34 weeks' gestation.

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