Multivariate Analyses of the Relationship between Umbilical Cord Length and Obstetric Outcome

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To investigate the clinical significance of umbilical cord length in human pregnancies, 1087 deliveries at Kaohsiung Chang Gung Memorial Hospital from May 1995 to August 1995 were studied. Our data showed that male fetuses had longer cord length than female and vertex presentation had longer cord length than breech presentation. The cord length and placental weight were significantly related to the birth weight. We found that: 1) only intrauterine growth retardation was associated with the increased risk of fetal distress; 2) secondary arrest of labor and advanced gestational age were correlated with meconium stain; and 3)birth weight and presence of meconium stain were correlated with the secondary arrest ($p<0.05$). However, there was no significant correlation between umbilical cord length and fetal well-being. As a result of multivariate analyses, we conclude that the umbilical cord length does not significantly correlate with either maternal age, gestational age (≧ 28 weeks), parity fetal outcome or intrauterine fetal well-being. Birth weight is the only characteristic that is correlated with cord length.(Chang Gung Med J 1996;19:247-52)

Key words: umbilical cord length, multivariate analyses, correlation.

Several intrapartum complications including meconium stain, birth asphyxia, fetal heart beat deceleration and entanglement of the cord around fetuses may lead to neonatal death or lifelong handicaps. Some noninvasive methods, such as real-time ultrasound and fetal monitoring, have been used to identify patients with a high risk pregnancy in order to lower perinatal morbidity or mortality. The intrapartum stillbirth rate and the neonatal death rate decreased with the use of fetal monitoring [1].

Although there is no direct proof, much evidence has demonstrated that intrapartum complication rate increases directly with the measured length of the umbilical cord after delivery [4-8,10-12,15]. Some indicated that abnormal cord length might be a marker for subsequent fetal development impairments [13]. However, the relationship between cord length and perinatal adverse events in Taiwanese babies has not been defined.

This study investigated: 1) the relationship between cord length and fetal outcome, and 2) whether cord length is correlated with maternal age, gestational age (≧28 week), parity, baby sex, placental weight or birth weight.

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MATERIALS AND METHODS

One thousand and eighty-seven deliveries with gestational age over 28 weeks at Kaohsiung Chang Gung Memorial Hospital from May 1995 to August 1995 were studied in this prospective study. Total cord length was measured from the cord stump on the baby to the portion attached to the placenta by a sterilized paper ruler immediately after delivery. Thin or thick meconium stain in the amniotic fluid was judged after rupture of the membrane. Secondary arrest of labor course was defined as the arrest of cervical dilatation or fetal head descent for more than two hours. Fetal distress was defined as severe variable deceleration, persistent prolonged bradycardia, repeated late deceleration or unexplained loss of beat-to-beat variability on fetal monitoring. An unpaired student t-test was applied for univariate analysis on continuous variables. A simple linear regression model was used to define the relationships between cord length, placenta weight and birth weight. Multivariate analyses were performed with logistic regression sequentially by using SPSS software (Interpretation & uses of Medical statistics, 3rd edition 8.9). Criteria for variable selections were as follows: limits to enter or remove variables in the regression equation must have a 5% probable value; the ratio between the corresponding regression coefficient and its standard error must be greater than 2. Multivariate odds ratios and their 95% confidence interval were also calculated.

RESULTS

Based on the analysis of 1087 deliveries, the umbilical cord length was positively correlated with birth weight with a tendency of adding 0.74 cm from the birth weight increased per 100 gm ($p<0.05$) (Fig. 1). The placental weight was also correlated to birth weight with a small (8.3 gm/100 gm birth weight increased) but significantly positive correlation ($p<0.05$) (Fig. 2). Male fetuses generally had statistically significant longer cord length than that of female fetuses (mean $\pm$ SD: 56.48 $\pm$ 9.72 cm vs. 54.94 $\pm$9.35 cm). We also found that the mean cord length in the vertex presentation group was statistically significant longer than that of the breech group

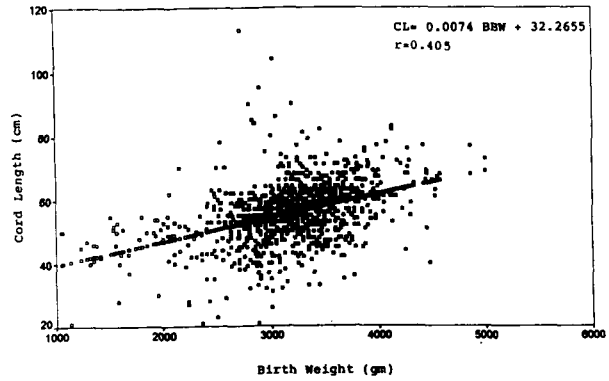

Fig. 1 A scattered plot demonstrating the correlation between cord length and birth weight.

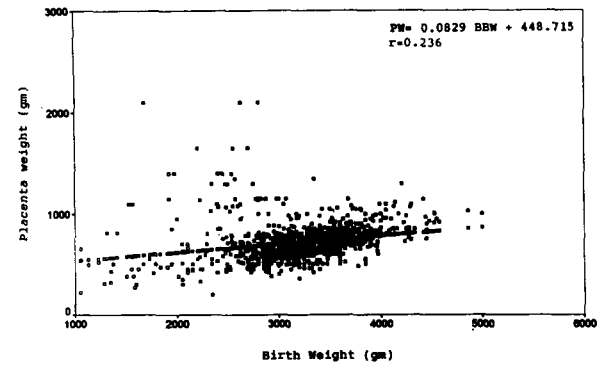

Fig. 2 A scattered plot demonstrating the correlation between placenta weight and birth weight.

Table 1. The Mean Length of the Umbilical Cord in Different Sex and Lie/Presentation of Fetuses

	Case no.	Cord length(cm) mean $\pm$ SD	p
Sex			
male	574	56.48 $\pm$ 9.72	0.008
female	513	54.94 $\pm$ 9.35	
Lie /presetation			
vertex	1008	56.08 $\pm$ 9.28	< 0.001
breech	79	51.44 $\pm$ 12.16	

Table 2. Multiple Logistic Regression Model for the Relationship between Six Variables and Fetal Distress

Variable	Odds ratio	95% Confidence interval	p
BBW	0.9992	(1.00,1.00)	.9215
CL	1.0329	(0.95,1.08)	.7101
GA	0.3734	(0.64,1.28)	.5873
IUGR	16.7601	(7.36,38.18)	.0143*
SA	3.2430	(0.35,30.03)	.3015
CE	5.6570	(0.54,4.93)	.4568

* p <0.05
BBW: birth weight; CL: cord length; GA: gestational age
IUGR: intrauterine growth retardation; SA: secondary arrest of labor; CE: cord entanglements

Table 3. Multiple Logistic Regression Model for the Relationship between Five Variables and Meconium Stain

Variable	Odds ratio	95% Confidence interval	p
SA	5..7065	(2.45,13.28)	.0001*
GA	1.3026	(1.12,1.51)	.0006*
FD	3.2795	(0.94,11.42)	.0621
BBW	0.9997	(1.00,1.00)	.1871
CL	1.0167	(0.99,1.04)	.1409

* p < 0.05
SA: secondary arrest; GA: gestational age; FD: fetal distress
BBW: birth weight; CL: cord length

Table 4. Multiple Logistic Regression Model for the Relationship between Six Variables and Secondary Arrest of Labor

Variables	Odds ratio	95% Confidence interval	p
MS	6.1282	(2.64,14.21)	< 0.0001*
FD	2.3943	(0.24,24.09)	.4585
BBW	1.0013	(1.00,1.00)	.0047*
CL	1.2737	(0.98,1.07)	.2941
SEX	1.3339	(0.58,3.07)	.4989
MA	0.9972	(0.90,1.10)	.9557

* p < 0.05
MS: meconium stain; FD: fetal distress; BBW: birth weight
CL: cord length; SEX: sex of fetuses; MA: maternal age

Table 5. Multiple Regression Analysis for the Relationship between Cord Length and Five Variables

Variables	Regression coefficients(b)	p
GA	.2576	.1550
BBW	.0067	<.0001*
PW	-.0002	.8858
P	1.0695	.0517
MA	.0774	.2421
Constant	20.4341	.0023

*p <0.05
GA: gestational age; BBW: birth weight; PW: placenta weight
P: parity; MA: maternal age

by 4.6 cm(mean ± SD: 56.08 ± 9.28 cm vs. 51.44 ±12.16 cm) (Table 1).

A total of 15 babies suffered from fetal distress and 98 fetuses had cord entanglements among the 1087 deliveries in our study. However, there was no fetal distress occurred among the 98 babies with cord around fetuses. The occurrence of fetal distress was not associated with fetuses having cord entanglements ($p>0.05$). Further analysis showed that only intrauterine growth retardation (IUGR) was associated with increased risk of fetal distress, but other factors including cord length, birth weight, gestational age (≧28 week), cord entanglements, etc., had no significant influence on fetal distress (Table 2). There was no statistical significance between fetal distress and cord length.

Secondary arrest of labor and advanced gestational age were associated with the increased risk of meconium stain (Table 3). There was also no significant correlation between cord length and the occurrence of meconium stain.

The presence of meconium stain in the amniotic fluid and fetal birth weight were positively correlated with the risk of secondary arrest of labor (Table 4). No evidence of correlation between cord length and secondary arrest of labor was found.

Multivariate analysis of cord length on maternal age, gestational age (≧28week), parity, placenta weight and fetal birth weight showed that birth weight was the only factor that correlated with umbilical cord length (Table 5).

DISCUSSION

Several articles concerning human umbilical cord length and intrapartum complications have been published in the past few decades. Various reports have demonstrated that a short cord was associated with birth asphyxia, abruptio placenta, unexplainable hematoma, irregular fetal heart beat, oligohydramnios, breech presentation and prolonged second stage of labor [4-8,11,15]. On the contrary, a long cord was frequently associated with cord accident, vertex presentation, venous thrombosis, throbocytopenia, central nervous system damage and fetal distress [5-10,12,15]. Naeye(1985) also stated that short cord might be an indicator for child motor or mental impairment and a subsequently low IQ value[13]. Especially in early pregnancy, an excessive spiralling of a long cord and stricture at fetal end of a cord were common accompaniments in cases of unexplained fetal death [15].

In our series, there is no significant correlation between umbilical cord length and fetal distress, meconium stain or secondary arrest of labor (Table 2-4). As we know, the multiple logistic model is a commonly used statistical tool that allows the examination of a risk factor for an adverse outcome independently of other covariates. So we used the stepwise logistic regression for multivariate analyses to obtain these results.

Percy Malpas (1964) assumed the two indices of embryonic growth, namely birth weight and placental weight were incompletely correspondent to cord length. In our multivariate analyses, the placental weight did show a linear correlation to birth weight (Fig. 2). We also found that cord length was significantly related to the birth weight (Fig. 1). However, wide variation of cord length and placenta weight among fetuses with the same gestational age were also observed.

According to our study, male fetuses generally had longer cords than female fetuses; the average cord length in the group of vertex presetation was longer than that of breech presentation by about 4.6 cm, which was consistent with a previous report by Soernes, et al [14] in 1986. Tompkins (1946) and Moessinger, et al (1982) stated that fetal motor activity could affect the umbilical cord length and fetuses with decreased motor activity tend to be associated with breech presentation [8,14]. Although our results were in concordance with the previous researches, we could not ensure whether the fetal lie/presentation could affect the umbilical cord length or not because we never recorded or compared the fetal motor activity between vertex and breech presentation groups to support the theories.

For the sake of comparison, the choice of the cut-off point at 28 weeks of gestation is based on the previous studies [2,3] that showed umbilical cord growth ceased or markedly reduced after 28 weeks of pregnancy.

Although the umbilical cord length was correlated with maternal age, gestational age and parity by univariate analysis. When these factors were compared with other variables by a stepwise multivariate analyses model, they were no more significantly related to the cord length. Only birth weight was correlated with the umbilical cord length. We highly suspected that increased gestational age, advanced maternal age and increased parity were inter-related, and all were correlated to an increased fetal birth weight.

In our study, the cord length as well as birth weight, gestational age and cord entanglements did not correlate with the fetal distress, but IUGR did. There has been no convincing evidence to prove that knowing the length of the umbilical cord could be helpful to predict or prevent fetal accident or distress.

Besides, neither cord length nor birth weight was associated with the occurrence of meconium stain. The secondary arrest of labor and advanced gestational age, on the other hand, could increase the incidence of meconium stain. We suppose the fetuses suffered from some unfavorable stress during the secondary arrest of labor or from advanced-gestational-age mother might induce fetal hypoxia, consequently increased the incidence of meconium passage. Therefore, we should pay special attention to such babies as the meconium aspiration syndrome is extremely difficult to care for and leads to major neonatal mortality.

We conclude that the umbilical cord length is significantly correlated with the birth weight of fetuses but bears no relationship with the maternal age, gestational age ($\geq$28week), parity, fetal outcome or intrauterine fetal well-being by multivariate analyses.

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多變數統計分析胎兒臍帶長度與產科預後的相關性

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爲了評估胎兒臍帶長度的臨床意義，在1995年5月至8月間，高雄長庚紀念醫院婦產科系共經歷了1087例滿28週的生產數。經多變數統計分析結果顯示：男嬰臍帶長度比女嬰長，而頭產式胎兒比臀產式胎兒有較長之臍帶。同時，胎兒出生體重與臍帶長度或胎盤重量有正相關性，而且我們發現：1) 唯有胎兒生長遲滯與胎心窘迫之發生有密切相關連。2) 懷孕週數較大及產程遲滯則與胎便出現與否有正相關。3) 胎便出現及胎兒體重則與產程遲滯有正相關.但是我們並未發現臍帶長短與子宮內胎兒狀況良否有任何相關連。所以我們的結論是：經由多變數統計分析，臍帶長度和母親年齡，妊娠週數(≧28 weeks)，胎次以及胎兒在母體內之狀況是否良好或胎兒預後並沒有明顯的相關性；唯有胎兒體重與臍帶長度有明顯的相關。(長庚醫誌1996；19：247-52)

關鍵字：臍帶長度，多變數統計分析，相關性。

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