
OBSTETRICS

The Association between Antenatal Umbilical Cord Coiling Index Pattern and Meconium-stained Amniotic Fluid in Gestational Diabetic Mellitus

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ABSTRACT

Objective: To compare the pattern of antenatal umbilical cord coiling index (aUCI) with meconium-stained amniotic fluid in gestational diabetic mellitus (GDM) women.

Materials and Methods: Gestational diabetic mellitus women between 28 weeks to 32 weeks and 6 days of gestation were included for standard ultrasonography with umbilical cord coiling measurement from a reciprocal value of the distance between a pair of coils ($aUCI = 1/\text{distance in cm}$). All pregnant women were divided into 2 groups (abnormal aUCI and normal aUCI) and recorded meconium-stained amniotic fluid before delivery. After delivered, total umbilical cord were measured for postpartum umbilical cord coiling index (pUCI).

Results: Total of 149 GDM women, 58 women were abnormal aUCI (38.93%). The abnormal aUCI showed significantly association with meconium-stained amniotic fluid ($p=0.046$), low Apgar score ($p=0.023$) and neonatal hypoglycemia ($p=0.018$) when compared with normal aUCI group. The correlation of aUCI and pUCI was poor ($p=0.554$).

Conclusion: This study showed that abnormal aUCI in GDM women was significantly associated with meconium-stained amniotic fluid. However, the aUCI had poorly correlation with pUCI.

Keywords: antenatal umbilical cord coiling index, meconium-stained amniotic fluid, gestational diabetic mellitus

Introduction

Gestational diabetic mellitus (GDM) is defined as carbohydrate intolerance of variable severity with onset or first recognition during pregnancy⁽¹⁾. The incidence of GDM has increased approximate 40% between 1989 and 2004⁽²⁾. In Thailand, GDM was found about 4-12% from previous study⁽³⁾ and 6-17% in our

institute during 2007-2011.

There are many important maternal effect from GDM such as polyhydramnios, preterm birth, preeclampsia, increased cesarean section and adverse fetal outcome such as macrosomia, fetal death, respiratory distress syndrome and neonatal hypoglycemia etc⁽¹⁾. The prognostic factor for poor

pregnancy outcome mainly depends on maternal blood glucose level. Usually, the antepartum ultrasonography was used to evaluate fetal anatomy, fetal weight and amniotic fluid level. However, there was no methods that could predict hypoxic events that may happen during intrapartum period.

The meconium-stained amniotic fluid is one cause of antepartum and intrapartum birth asphyxia. In study in 2006⁽⁴⁾ showed the umbilical cord coiling index (UCI, UCI = total number of complete umbilical vascular coil/total cord length in centimeter) that were measured from umbilical cord after delivery and divided UCI into 3 patterns as hypocoiled, normocoiled and hypercoiled cord using cutpoint lower than 10 percentile, between 10-90 percentile or higher than 90 percentile curve respectively. This study showed significant correlation between abnormal UCI (hypercoiled and hypocoiled cord) with meconium-stained amniotic fluid ($p=0.03$) and cesarean section due to fetal distress ($p=0.03$)⁽⁵⁾. These results were the same as another studies^(4,6-8). The abnormal postpartum UCI (pUCI) which were hypercoiled and noncoiled cord was found higher in GDM ($p=0.004$, 0.008 , respectively) when compared with normal pregnancy⁽⁶⁾. Moreover, the abnormal pUCI in GDM associated with meconium significantly⁽⁶⁾. In recently, many authors measured UCI using ultrasonography during second trimester of pregnancy called antenatal UCI (aUCI) and reported the good correlation with pUCI^(9,10). Furthermore, abnormal aUCI associated with low birth weight and non-reassuring fetal status^(11,12). However, there is no report about aUCI in GDM before.

This study aimed to evaluate the association between aUCI pattern and meconium-stained amniotic fluid and to assess the correlation between aUCI and pUCI in GDM.

Materials and Methods

All pregnant women who attended the antenatal care at Vajira hospital were screened for GDM with 50-g glucose challenge test at first visit if they were high risk group and the others did between 24-28 weeks of gestation based on the recommendation of fifth international workshop-conference on Gestational

Diabetes⁽¹⁾. A value of ≥ 140 mg/dL is positive test, should undergo to diagnostic test. The standard recommended by the American College of Obstetrics and Gynecologist (2001) to diagnose GDM is the 100-g 3-hour oral glucose tolerance test performed after and overnight fast (95 mg/dL in fasting, 180 mg/dL in 1 hour, 155 mg/dL in 2 hours and 140 mg/dL in 3 hours). Two or more of the venous plasma glucose concentrations indicated below must be met or exceeded for positive diagnosis. After diagnosis of GDM, the singleton pregnant women between 28-32 weeks 6 days of gestation (Gestational diabetes screening has been reached and Gestational age at most Umbilical cord can be measured from ultrasound) were recruited into this study. The fetus which had fetal anomaly, abnormal chromosome, single umbilical artery, preterm birth (< 36 weeks of gestation), dead fetus in utero, oligohydramnios and maternal condition such as hypertension, vascular disease and delivered outside Vajira hospital were excluded. This prospective cross sectional study was approved by Ethic Committee of the Faculty of Medicine, Vajira hospital, University of Bangkok Metropolis, Bangkok, Thailand (COA25/2555). The training period for umbilical cord measurement was three months prior to study. Population of this study calculated in compared two proportion⁽¹³⁾ analyzed by STATA version 12 and collected until at least 57 GDM women in each groups based on relationship of UCI and meconium-stained amniotic fluid from Ezimokhai M, et al⁽⁶⁾.

After obtaining a written informed consent, all examinations were performed by one sonographer (Kamolchanok Anusasanant) to avoid inter-observer variability. Intra-observer reliability was calculated by 50 randomized cases. A standard fetal parameters, anatomical scan, amniotic fluid level measurements with 2D transabdominal scan were performed first using a RAB 2-5D probe (LOGIC P6 or Voluson E8; GE medical Systems, Milwaukee, WI, USA). The measurement pictures were collected and approved by perinatologist (Sornpin Armarattasarn).

Afterwards, the umbilical cord coiling was measured at free loop of umbilical cord as showed in Fig.1, longitudinal view of the umbilical cord was

obtained at maximum magnification and the length between coils was measured from the inner edge of an arterial wall to the outer edge of the next. Three times measurements were done and the aUCI value was calculated from 1/distant between coil in centimeter⁽¹¹⁾, the greatest aUCI value was used for further analysis then categorized aUCI into 3 groups; hypercoiled (> 0.64 coil/cm), hypocoiled (< 0.27 coil/cm) and normocoiled ($0.27 - 0.64$ coil/cm.) using reference values from nearest gestation aged in recently study⁽¹¹⁾.

The day of delivery (gestational age between 36 ot 42 weeks), the appearance of amniotic fluid were recorded at admission and whenever meconium were detected. Umbilical cord was measured within 1 hour after placental delivery. One coil defined as complete 360 degrees of umbilical artery around umbilical vein. The postpartum UCI (pUCI) was calculated from total number of complete umbilical vascular coil/ total length of umbilical cord in centimeters and using referenced pUCI value from often used as a reference study⁽⁵⁾,

hypocoiled (≤ 0.1 coil/cm), normocoiled (between 0.1-0.3 coil/cm) and hypercoiled cord (≥ 0.3 coil/cm). Obstetric data were recorded from OPD card and labor record. Our study divided umbilical cord coiling pattern into 2 groups; Abnormal coiled pattern (combination of hypercoiled and hypocoiled cord) and normocoiled pattern. All data were analyzed by SPSS version 11.5, Intraclass correlation coefficients (ICCs) was used to determine intra-observer reliability (An ICCs > 0.7 is used to indicate adequate reliability, analyzed by two way mixed effect model), Quantitative data were reported in mean, median or SD, Qualitative data were reported in percentage, Comparing of pattern of aUCI with meconium-stained amniotic fluid and other outcomes were reported with Chi-square and fisher's extract test in each group. The correlation between aUCI to pUCI was assessed with Pearson's correlation. A p-value less than 0.05 was considered statistically significant.



Fig. 1. Umbilical cord coiling measurement using ultrasonography

The umbilical cord coiling was measured at free loop of umbilical cord, longitudinal view of the umbilical cord was obtained at maximum magnification and the length between coils was measured from the inner edge of an arterial wall to the outer edge of the next.

Table 1. Demographic data of normocoiled and abnormal coiled groups

Characteristic	Normocoiled group (N = 91)	Abnormal coiled group (N = 58)	p
Age (n,%)			
< 35 yr	53 (58.24)	37 (63.79)	0.499
≥ 35 yr	38 (41.76)	21 (36.21)	
Nationality (n,%)			
Thai	83 (91.21)	54 (93.31)	0.841
Myanmar	5 (5.49)	3 (5.17)	
Lao	3 (3.30)	1 (1.72)	
Parity (n,%)			
Nulliparity	32 (35.16)	10 (17.24)	0.018*
Multiparity	59 (64.84)	48 (82.76)	
Type of GDM (n,%)			
Insulin	18 (19.78)	18 (31.03)	0.118
Diet control	73 (80.22)	40 (68.97)	
Route of delivery (n,%)			
Normal labor	49 (53.85)	33 (56.90)	0.693
Vacuum extraction	1 (1.10)	0	
Forceps extraction	2 (2.20)	3 (5.17)	
Cesarean section	39 (42.86)	22 (37.93)	
Birth weight (g) (Mean ± SD)	3119.78 ± 412.71	3168.10 ± 499.60	0.522
GA at cord USG; days (mean ± SD)	209.80 ± 10.81	210.03 ± 9.36	0.862
GA at Birth; days (mean ± SD)	268.4 ± 7.13	265.88 ± 6.82	0.034*

Results

From April 2012 to August 2013, there were 63 abnormal coiled pattern and 94 normocoiled pattern in GDM women. We excluded 5 abnormal coiled pattern, 4 cases from delivered outside the hospital and one neonatal anomaly (diaphragmatic hernia) and 3 normocoiled pattern from incomplete data.

From demographic data showed in Table 1, no difference in maternal age, race, type of GDM, route of delivery, mean birth weight, gestational age on the day of ultrasound between 2 groups but showed significant higher in parity and gestational age at birth from normocoiled group.

Intra-observer reliability of ultrasonography measurement was studied in 50 of 157 cases. The ICCs were higher than 0.7 (Table 2).

Table 3 demonstrated the distribution of aUCI and pUCI. Even through, the normocoiled pattern was the most common pattern in GDM. In the pUCI, the data showed 64 cases (41.62%) in abnormal pattern. Finally, antepartum UCI had poor correlation with pUCI ($p=0.554$).

Neonatal outcome was demonstrated in Table 4. In this study was found significant higher of meconium-stained amniotic fluid, low Apgar score in first minute and neonatal hypoglycemia in abnormal coiled group ($p=0.046$, 0.023 and 0.018 respectively). Low birth weight, IUGR and NICU admission were not difference between 2 groups. If compare between low Apgar score and amniotic fluid appearance, there were 2/29 cases (6.3%) of meconium-stained amniotic fluid, while 4/120 cases (3.3%) of clear amniotic fluid. That mean

meconium-stained amniotic fluid found low Apgar score was two-fold. For pUCI, that was found significant higher of meconium-stained amniotic fluid, low Apgar

score in first minute and neonatal hypoglycemia in abnormal coiled group (0.038, 0.034, and 0.003), likely resulted of aUCI.

Table 2. Intra-observer reliability of aUCI measurement

aUCI measurement	ICC	95%CI
Individual	0.993	0.989 to 0.996
Average	0.997	0.996 to 0.998

Table 3. Distribution of aUCI and pUCI in GDM

	Hypocoiled cord	Normocoiled cord	Hypercoiled cord
aUCI (n,%)	27 (18.12)	91 (61.07)	31 (20.18)
pUCI (n,%)	31 (20.81)	87 (58.39)	31 (20.81)

aUCI, antepartum umbilical coiling index; pUCI, postpartum umbilical coiling index

Table 4. The association between pattern of aUCI and neonatal outcome

Outcome	Normocoiled group	Abnormal coiled group	p
	(N=91)	(N=58)	
LBW (n,%)	6 (6.59)	3 (5.17)	0.723
Low Apgar score in 1 min. (n,%)	1 (1.1)	5 (8.62)	0.023*
Meconium (n,%)	13 (14.29)	16 (27.59)	0.046*
IUGR (n,%)	0	2 (4.76)	0.131
Hypoglycemia (n,%)	6 (6.59)	11 (19.30)	0.018*
NICU admission (n,%)	0	1 (2.13)	0.356

LBW, low birth weight (less than 2,500 g); IUGR, intrauterine growth restriction

Discussion

This is the first study about antepartum umbilical cord coiling pattern in GDM. From this study found 39% of abnormal coiled cord in GDM which higher than statistic data in 2005 from normal pregnancy (21.2%)⁽¹⁰⁾ and higher abnormal pUCI than previous GDM study (42.6% and 33.1%)⁽⁶⁾.

The cause of umbilical cord coiling is unknown, that may correlated with fetal movement and/or unequal vessel growth rate⁽¹²⁾. However, previous study showed association between abnormal aUCI and meconium-stained amniotic fluid but no significantly⁽¹²⁾. The meconium can pass when hypoxia stimulates arginine vasopressin (AVP) release from the fetal pituitary gland.

AVP stimulates the smooth muscle of the colon to contract, resulting in intra-amniotic defecation⁽¹⁾. This study confirmed the association between aUCI and meconium-stained amniotic fluid which could be use umbilical cord ultrasound during early last trimester for prediction of fetal hypoxia during intrapartum period. However, the correlation between aUCI and pUCI from our study was poor (p=0.554) ,because of characteristics of umbilical coiling is not constant pattern along the total cord length so the only one area of ultrasound may not be indicative of whole umbilical cord ,same as Qin Y et al⁽¹⁴⁾, but difference from other studies^(9,10). However this study, both of aUCI and pUCI could predict meconium in amniotic fluid.

This study was found no significant relationship between aUCI with mode of deliver and interventional delivery same Yun Sung Jo et al⁽¹¹⁾. We found the significant in correlation of low apgar score and gestational age at birth with abnormal aUCI ,difference from other study^(11,12,15).

Degani et al⁽¹⁵⁾, showed higher prevalence of SGA neonate and intra-partum non reassuring status, but not significant in this research. It is possible from too small of subjects in this study and GDM pregnancy tend to have large fetus more than normal pregnancy. Previously, many study purposed significant associated of aUCI and fetal outcome but not specifically in maternal group. So in GDM pregnant may have difference outcome.

Furthermore, this study was found newly significant of neonatal hypoglycemia associated with abnormal coiled pattern, the results may be guided to used the aUCI for prediction of neonatal hypoglycemia in GDM but should be confirmed with larger sample size and compare with blood glucose level monitoring. In the future, umbilical cord coiling assessment by ultrasound during early last trimester may be use for prediction of fetal hypoxia during intrapartum period.

Conclusions

This study showed that abnormal aUCI in GDM women was significantly associated with meconium-stained amniotic fluid. However, the aUCI had poorly correlation with pUCI.

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รูปแบบของการบิดเกลี้ยงเส้นเลือดสายสะดือก่อนคลอดกับการถ่ายชี้เทาในน้ำคร่ำในสตรีที่เป็นโรคเบาหวานขณะตั้งครรภ์

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วัตถุประสงค์: เพื่อศึกษาความสัมพันธ์ระหว่างรูปแบบการบิดเกลี้ยงเส้นเลือดสายสะดือก่อนคลอด (aUCI) กับการถ่ายชี้เทาในน้ำคร่ำของสตรีที่เป็นโรคเบาหวานขณะตั้งครรภ์

วิธีการวิจัย: เป็นการศึกษาไปข้างหน้าแบบ cross sectional ทำการศึกษาในสตรีตั้งครรภ์เดี่ยวที่ได้รับการวินิจฉัยเป็นเบาหวานขณะตั้งครรภ์อยุคครรภ์ 28 สัปดาห์ถึง 32 สัปดาห์ 6 วัน โดยทำการตรวจคลื่นเสียงความถี่สูงและวัดรูปแบบของ aUCI ซึ่งมีค่าเท่ากับ 1 หารด้วยความยาวระหว่าง 2 เกลลียงของเส้นเลือดแดงสายสะดือ (เซนติเมตร) โดยแบ่งลักษณะของ aUCI เป็น 2 กลุ่ม (aUCI ที่ปกติ และผิดปกติ) เมื่อถึงระยะเวลาที่ถูกกำหนดให้ทำการบันทึกลักษณะของน้ำคร่ำ หลังจากคลอดทำการวัดความยาวและจำนวนการบิดเกลี้ยงของเส้นเลือดของสายสะดือเพื่อหารูปแบบของการบิดเกลี้ยงเส้นเลือดสายสะดือหลังคลอด (pUCI)

ผลการวิจัย: ประชากรทั้งหมด 149 คน พบ aUCI ที่ผิดปกติ 58 คน (38.93%) โดยกลุ่ม aUCI ที่ผิดปกติมีความสัมพันธ์กับการถ่ายชี้เทาในน้ำคร่ำ ภาวะแทรกซ้อน Apgar score ต่ำ และภาวะน้ำตาลในเลือดต่ำของทารกอย่างมีนัยสำคัญ ($p=0.046, 0.023, 0.018$ ตามลำดับ) และเมื่อศึกษาความสัมพันธ์ของ aUCI และ pUCI พบว่ามีความสัมพันธ์กันต่ำ ($p=0.554$)

สรุป: aUCI ที่ผิดปกติในสตรีที่เป็นเบาหวานขณะตั้งครรภ์มีความสัมพันธ์กับการถ่ายชี้เทาในน้ำคร่ำ และความสัมพันธ์ของ aUCI และ pUCI ในกลุ่มสตรีที่เป็นเบาหวานขณะตั้งครรภ์อยู่ในระดับต่ำ
