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Transvaginal Ultrasound Measurement of the Uterocervical Angle for Prediction of Spontaneous Preterm Birth

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ABSTRACT

Objectives: To determine the predictive values for spontaneous preterm birth by using transvaginal ultrasonography of the uterocervical angle (UCA) in pregnant women with 16-24 weeks' gestation

Materials and Methods: A prospective cohort study was conducted in singleton pregnant women with 16-24 weeks' gestation. The UCA was performed at the time of cervical length screening. The data were recorded. Then the predictive values for spontaneous preterm birth were calculated.

Results: The data from 528 pregnant women was analyzed. Fifty-nine women developed spontaneous preterm birth and seven of these developed preterm birth at < 34 weeks. The UCA was significantly wider in preterm group when compare with controls (102.8 degrees vs 88.7 degrees, $p < 0.001$). The sensitivity, specificity, positive predictive value and negative predictive values of the UCA more than 95 degrees for prediction of spontaneous preterm birth were 74.6%, 64.6%, 21.0% and 95.3% respectively.

Conclusion: A wide uterocervical angle > 95 degrees detected during the second trimester was associated with an increased risk for spontaneous preterm birth < 37 weeks. This data showed that the uterocervical angle may be used as a screening tool for spontaneous preterm birth.

Keywords: cervical length, preterm birth, transvaginal ultrasound, uterocervical angle.

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การใช้คลื่นเสียงความถี่สูงทางช่องคลอดเพื่อวัดมุมระหว่างมดลูกส่วนล่างและปากมดลูก เพื่อใช้ทำนายการคลอดก่อนกำหนด

กุลวดี กิติพูลวงษ์วนิช, อัจจิมา สูงสถิตานนท์

บทคัดย่อ

วัตถุประสงค์: *เพื่อศึกษาประสิทธิผลในการทำนายการคลอดก่อนกำหนดโดยใช้การวัดค่ามุมระหว่างมดลูกส่วนล่างกับปากมดลูกทำโดยใช้คลื่นเสียงความถี่สูงทางช่องคลอด ในสตรีที่อายุครรภ์ 16-24 สัปดาห์*

วัสดุและวิธีการ: *เป็นการศึกษาไปข้างหน้าในสตรีครรภ์เดี่ยวอายุครรภ์ 16-24 สัปดาห์ ที่มาฝากครรภ์ในโรงพยาบาลวชิรพยาบาล ตั้งแต่ 26 มีนาคม 2561 ถึง 30 พฤศจิกายน 2561 โดยสตรีตั้งครรภ์จะได้รับการวัดมุมระหว่างมดลูกส่วนล่างและปากมดลูกในช่วงเวลาที่มารับการตรวจวัดความยาวปากมดลูกโดยใช้คลื่นเสียงความถี่สูงทางช่องคลอด ทำการบันทึกข้อมูลลงในแบบบันทึกข้อมูล และวิเคราะห์ความไวและความจำเพาะต่อการเกิดภาวะคลอดก่อนกำหนด*

ผลการศึกษา: *จากการศึกษาสตรีตั้งครรภ์ทั้งหมด 528 ราย พบว่ามีสตรีตั้งครรภ์คลอดก่อนกำหนด 59 ราย (ร้อยละ 11.2) และสตรีตั้งครรภ์ 7 ราย ใน 59 ราย มีการคลอดก่อน 34 สัปดาห์ สตรีตั้งครรภ์ที่คลอดก่อนกำหนดมีมุมระหว่างมดลูกส่วนล่างกับปากมดลูกกว้างกว่ากลุ่มที่คลอดครบกำหนด อย่างมีนัยสำคัญ (102.8 องศาเทียบกับ 88.7 องศา, $p < 0.001$) และค่ามุมระหว่างมดลูกส่วนล่างกับปากมดลูกที่มากกว่า 95 องศา สามารถใช้ทำนายการคลอดก่อนกำหนด โดยมีค่าความไวร้อยละ 74.6 ความจำเพาะร้อยละ 64.6 ค่าทำนายผลบวกร้อยละ 21.0 และค่าทำนายผลลบร้อยละ 95.3*

สรุป: *ค่ามุมระหว่างมดลูกส่วนล่างกับปากมดลูกที่กว้างกว่า 95 องศา ในช่วงไตรมาสที่สองของการตั้งครรภ์สัมพันธ์กับการเพิ่มความเสี่ยงในการเกิดการคลอดก่อนกำหนดที่อายุครรภ์น้อยกว่า 37 สัปดาห์ ดังนั้นการวัดมุมระหว่างมดลูกส่วนล่างกับปากมดลูกอาจเป็นเครื่องมือที่ใช้คัดกรองสตรีตั้งครรภ์ที่มีความเสี่ยงในการคลอดก่อนกำหนด*

คำสำคัญ: *การคลอดก่อนกำหนด, การใช้คลื่นเสียงความถี่สูงทางช่องคลอด, ความยาวปากมดลูก, มุมระหว่างมดลูกส่วนล่างกับปากมดลูก*

Introduction

Preterm birth (PTB) is the main cause of neonatal morbidity and mortality[1,2]. It accounts for 80% of neonatal deaths and 50% of childhood neurodevelopmental disorders which is inversely related to gestational age at birth[3-5]. In Thailand, approximately 12% of births are preterm, ranking the 55th country in the world[6]. The prevention of preterm births requires early identification of at-risk pregnant women and interventions such as progesterone supplement or cerclage if required[7-9].

The evidence exists that a previous history of spontaneous preterm birth (sPTB) and short cervical length, as measured by transvaginal ultrasonography in second trimester, are signs of being at-risk of sPTB[8,9]. The detection rate of cervical length screening for prediction of sPTB is less than 30%[10]. Furthermore, the evidence of universal cervical length screening is controversial[11-13]. Thus, the new predictive strategies for sPTB are necessary.

Recently, the wide uterocervical angle (UCA) has been suggested as a predictor of preterm birth[14-16]. This hypothesis extends from the mechanism of action of the Arabin pessary that modifies the angle of the cervical canal in relation to the uterus. Thus, this modification might decrease the excessive pressure of the uterus directly on the cervix[17, 18].

The aim of this study was to determine the predictive values of UCA in predicting spontaneous preterm birth in the second trimester.

Materials and methods

This prospective cohort study was conducted at the Department of Obstetrics and Gynecology, the Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand between March 26th 2018 and November 30th 2018. The study was approved by the Institutional Review Board of the Faculty of Medicine, Navamindradhiraj University (protocol approval number COA 042/2561). All women were informed and signed the consent forms.

Singleton pregnant women between 16-24 weeks' gestation based on last menstrual period or first trimester ultrasound were included in the study. Women with multiple gestations, cervical cerclage, or with indications of preterm birth and fetal abnormalities were excluded from the study.

The sample size calculations were based upon the sensitivity of UCA for the prediction of preterm birth from the study of Dziadosz M, et al[14]. Thus, this study needed 525 women.

The outcome was the diagnosis of preterm birth. Preterm birth was defined as birth before 37 weeks of pregnancy[6]. The maternal demographic data, UCA, cervical length and maternal outcomes were recorded.

Uterocervical angle

The transvaginal UCA measurement was performed, as previously described[15], by 3 operators who were trained in person by the same fetal medicine trainer using GE Voluson E8 or GE Voluson P8 (GE Medical Systems, Zipf, Austria) at the time of universal cervical length screening. The maternal bladder was emptied before initiating the examination. With the real time image in view, the transducer is gently advanced into the anterior vaginal fornix until the amniotic fluid and cervix are visualized. After the endocervical mucosa and anterior uterine wall were identified, the distance between the internal os and external os was measured. The first caliper was placed from the external to internal os of the uterus. The second caliper was placed from internal os extended along the posterior side of the anterior wall of the uterus and the UCA was calculated by program (Fig.1). If the cervix was curved, the first ray was placed from the internal os to the external os as a straight line. If the uterus was retroverted, the angle was measured with the first ray along the measurable cervix and the second ray traced along the posterior lower uterine segment and the angle measured at posterior angle. The measurement of cervical length and UCA were done for 3 times. The shortest cervical length and the mean UCA were recorded. The interobserver and intraobserver coefficient variation

of UCA were compared for variability.

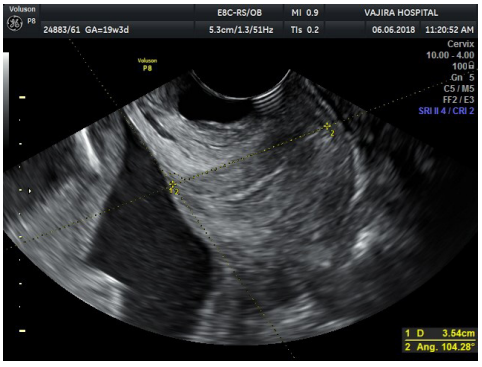

Fig. 1. Technical aspects for the measurement of the second-trimester UCA

Statistical analysis

All data were analyzed with the Stata version 13.0 program. The data were presented as mean, standard deviation (SD) and percentage. Fisher's exact test, χ^2 test, and Mann-Whitney U test were performed as appropriate. A p value of <0.05 was considered to be statistically significant. Receiver operating characteristic (ROC) and area under curve (AUC) were developed to determine an optimal UCA for prediction of preterm birth. Selecting the cut-off point with the Youden's index presented by sensitivity, specificity, accuracy, positive predictive value (PPV), negative predictive value (NPV) and ROC curve area with confidence interval of 95%.

Results

A total of 537 pregnant women were included in this study. Nine women were excluded (two women had cervical cerclage performed, two women were preeclampsia with severe features and five women were lost to follow-up) (Fig. 2).

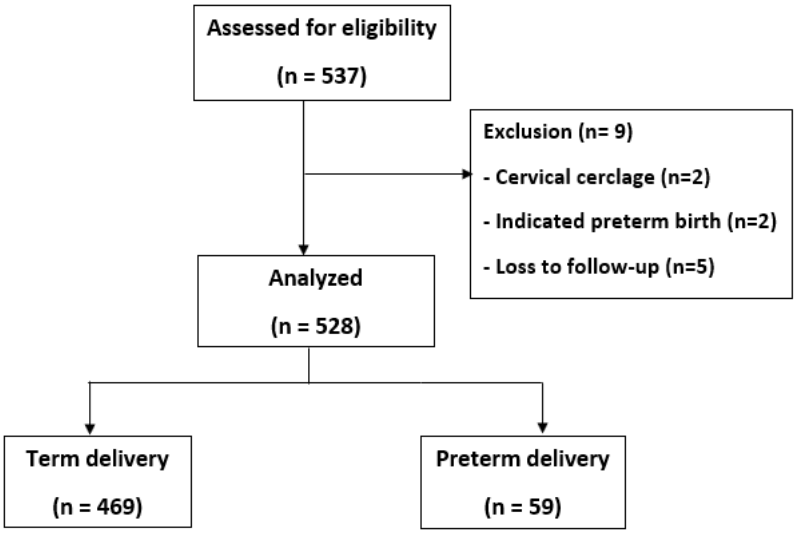

Fig. 2. A schematic diagram of study.

The data from 528 women were analyzed. Their mean age ± SD was 27.8 ± 6.4 years. Fifty-nine women developed spontaneous preterm birth (11.2%) and seven of these developed preterm birth at < 34 weeks (1.3%). Mean gestational age at preterm birth was 35.7±1.5 weeks. The demographic data of the pregnant women in this study are shown in Table 1. There were no statistically significant differences in maternal age, race, parity, body mass index (BMI), gestational age of measurement, smoking, alcohol drinking, drug abuse, in vitro fertilization (IVF), prior dilation and curettage, prior cervical surgery (conization, Loop electrosurgical excision (LEEP), abnormal Pap smear and mode of delivery between the pregnant women with preterm birth and term pregnant women. However, pregnant women with preterm birth were more likely to have had a prior sPTB when compared with term pregnant women.

Table 1. Demographic data.

Demographic	Total n=528		Birth ≥ 37 wk n=469 (88.8%)		Birth < 37 wk n=59 (11.2%)		p value*
Maternal age (year)	27.8 ± 6.4		27.8 ± 6.5		27.6 ± 5.7		0.826
Race							
Thai	424	(80.3)	379	(80.8)	45	(76.3)	0.409
Other	104	(19.7)	90	(19.2)	14	(23.7)	
GA at first antenatal care	14.4 ± 4.8		14.4 ± 4.7		13.8 ± 5.0		0.370
Primigravida	257	(48.7)	230	(49.0)	27	(45.8)	0.635
Body mass index at conception (kg/m^2)	22.8 ± 4.5		22.8 ± 4.5		22.2 ± 4.9		0.330
Risk factor							
Elderly gravidarum	83	(15.7)	75	(16.0)	8	(13.6)	0.629
Smoking	4	(0.8)	3	(0.6)	1	(1.7)	0.378
Alcoholic drinking	7	(1.3)	6	(1.3)	1	(1.7)	0.566
Drug abuse	2	(0.4)	2	(0.4)	0	(0.0)	1.000
IVF	5	(0.9)	5	(1.1)	0	(0.0)	1.000
Prior sPTB	12	(2.3)	8	(1.7)	4	(6.8)	0.035
Prior D&C	36	(6.8)	32	(6.8)	4	(6.8)	1.000
Prior cervical surgery	2	(0.4)	2	(0.4)	0	(0.0)	1.000
Abnormal Pap smear	2	(0.4)	2	(0.4)	0	(0.0)	1.000
GA at USG (wk)	19.8±1.6		19.8±1.6		20.0±1.6		0.236
Mode of delivery							
Vaginal delivery	357	(67.6)	313	(66.7)	44	(74.6)	0.225
Cesarean section	171	(32.4)	156	(33.3)	15	(25.4)	
GA at delivery (wk)	38.8±1.5		39.2±1.0		35.7±1.5		< 0.001

Data are presented as number (%) or mean± standard deviation.

* comparison between term and preterm birth group

GA: gestational age, IVF: In vitro fertilization, sPTB: spontaneous preterm birth, D&C: dilation and curettage, USG: ultrasonography

The pregnant women with preterm birth had a significantly wider UCA than controls (102.8 ± 22.0 degree; GA < 37 weeks vs 88.7 ± 21.4 degree; GA ≥ 37 weeks, p < 0.001); however, UCA was not significantly wider in pregnant women who delivered < 34 weeks. The cervical length was not statistically different in pregnant women who had preterm birth or delivered < 34 weeks when compared with controls (Table 2).

Table 2. Comparison uterocervical angle and cervical length between term and preterm birth (n=528).

Variables	GA ≥ 37 wk n=469 (88.8%)	GA < 37 wk n=59 (11.2%)	GA < 34 wk n=7 (1.3%)	p value*	p value**
Cervical length (mm)	35.8 ± 0.6	35.5 ± 0.7	-	0.734	-
	-	-	33.3 ± 0.8	-	0.268
Uterocervical angle (degree)	88.7 ± 21.4			< 0.001	-
	-	-	95.1 ± 21.1	-	0.431

* Comparison between GA ≥ 37 week and GA < 37 week
** Comparison between GA ≥ 37 week and GA < 34 week
GA: gestational age

Intraobserver and interobserver variability were assessed by Kappa statistics. The results were 0.98 for intraobserver and 0.97 for interobserver variability.

ROC curves were generated to evaluate UCA with gestational age at delivery. For prediction of spontaneous preterm birth < 37 weeks gestation, the area under the curve of UCA was 0.69 (p < 0.001; SE ±0.038; 95% confidence interval, 0.61 - 0.76) (Fig. 3).

The prediction of preterm birth by UCA more than 95 degree and cervical length less than 25 mm are shown in Table 3. When UCA more than 95 degree was used, the sensitivity, specificity, PPV and NPV for preterm birth were 74.6%, 64.6%, 21.0% and 95.3%, respectively. When CL less than 25 mm was used, the sensitivity, specificity, PPV and NPV for preterm birth were 3.4%, 98.7%, 25.0% and 89.0%, respectively (Table 3).

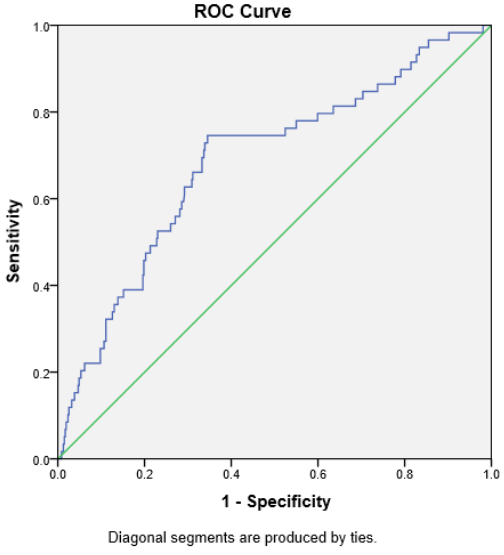

Fig. 3. Evaluating uterocervical angle for prediction of spontaneous preterm birth < 37 weeks.

Table 3. Test characteristics of uterocervical angle and cervical length for prediction of spontaneous preterm birth < 37 weeks.

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Positive	Negative likelihood ratio
UCA > 95 degrees	74.6 (61.6-85.0)	64.6 (60.1-68.9)	21.0 (15.7-27.1)	95.3 (92.3-97.3)	2.1 (1.74-2.55)	0.4 (0.25-0.61)
CL ≤ 25 mm	3.4 (0.4-11.7)	98.7 (97.2-99.5)	25.0 (3.2-65.1)	89.0 (86.0-91.6)	2.7 (0.55-12.83)	1.0 (0.93-1.03)

UCA: uterocervical angle, CL: cervical length

Discussion

This study demonstrated that UCA was a reproducible screening tool for predicting spontaneous preterm birth in the second trimester. The detection rate was 74.6%, which is better than cervical length in identifying pregnant women who delivered spontaneously at < 37 weeks.

The UCA in the present study was significantly wider in the women who had spontaneous preterm birth compared to the term pregnant women. This was similar to previous studies[14, 15]. In pregnant women who delivered at < 34 weeks, the UCA tended to be wider than controls, however the difference was not statistically significant. This was not consistent with previous studies[16,19]. The discrepancy may be due to a small sample size of pregnant women who delivered at < 34 weeks.

The sensitivity of a wide UCA in predicting sPTB in the present study was similar to studies by Dziadosz, et al[14] and Sochacki–Wójcicka, et al[15]. However, the sensitivity of cervical length < 25 mm in predicting sPTB in this study was lower than previous studies[10,14]. Celik, et al[10] from United Kingdom found the sensitivity of short cervical length in predicting sPTB was 24.2% in late preterm birth and Diadosz, et al[14] found the sensitivity was 15% in sPTB. The discrepancy may be due to the differences in ethnicities of the study populations and the small number of cases of cervical length < 25 mm.

The strength of this study was that the UCA was performed at the same time as the universal cervical length screening and screening for fetal anomaly. This was more convenient for the patient because two screenings were performed in one visit. The limitation of the study was the small number of pregnant women who delivered at < 34 weeks. Further study with more cases of pregnant women who delivered at < 34 weeks should be conducted.

In conclusion, this study demonstrated that UCA was wider in cases with preterm birth. It was an effective screening tool for sPTB in the second trimester.

Conclusion

A wide uterocervical angle > 95 degrees detected during the second trimester was associated with an increased risk for spontaneous preterm birth < 37 weeks. This data showed that the uterocervical angle may be used as a screening tool for spontaneous preterm birth.

Acknowledgements

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Potential conflicts of interest

The authors declare no conflict of interest.

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