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The Association between Anterior Uterocervical Angle and Pregnancy between 16-24 Weeks of Gestation

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ABSTRACT

Objectives: To determine the association between gestational age and anterior uterocervical angles measured between 16 and 24 weeks of pregnancy.

Materials and Methods: A descriptive cross-sectional study was conducted among pregnant women at gestational age between 16-24 weeks, specifically in those who had access to the antenatal care clinic at Rajavithi hospital, Bangkok, Thailand, between July 2017 and March 2018. The women underwent anterior uterocervical angle measurements by means of transvaginal ultrasonography, which was performed by a well-trained sonographer. A correlation and regression analysis between the anterior uterocervical angles and the gestational weeks were carried out, while a predictive nomogram of the anterior uterocervical angle was developed for potential cases of angle changes associated with advancing gestational age.

Results: A total of 249 pregnancies (at least 15 measurements per week of gestation) were included in the study. The anterior uterocervical angle was not significantly associated with gestational age at 16 0/7 – 24 6/7 weeks (Pearson's correlation, $r = 0.038$, $p = 0.553$). From the linear regression analysis, the parity was the significant factor associated with anterior uterocervical angle ($p < 0.001$). The mean ± standard deviation of anterior uterocervical angles were 96.1 ± 21.5 degrees and 108.9 + 20.0 degrees in the nulliparity and the multiparity groups, respectively.

Conclusion: The anterior uterocervical angle at 16-24 weeks was found to be independent of the gestational age. However, it was still significantly related to the parity.

Keywords: uterocervical angle, gestational age, preterm birth.

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ความสัมพันธ์ของมุมระหว่างปากมดลูกกับมดลูก กับอายุครรภ์ ในสตรีตั้งครรภ์ช่วงอายุครรภ์ 16-24 สัปดาห์

ตฤณญา ไชยวงศา, จิตติมา รุจิเวชพงศธร

บทคัดย่อ

วัตถุประสงค์: *เพื่อศึกษาความสัมพันธ์ของมุมระหว่างปากมดลูกกับมดลูกในสตรีตั้งครรภ์ อายุครรภ์ระหว่าง 16 - 24 สัปดาห์*

วัสดุและวิธีการ: *เป็นการศึกษาวิจัยเชิงพรรณนา ภาคตัดขวาง ทำการศึกษาในสตรีตั้งครรภ์ อายุครรภ์ระหว่าง 16 -24 สัปดาห์ ที่มารับการตรวจที่คลินิกฝากครรภ์ โรงพยาบาลราชวิถี ระหว่างเดือนกรกฎาคม พ.ศ. 2560 ถึง มีนาคม พ.ศ. 2561 ทำการวัดมุมระหว่างปากมดลูกและมดลูกโดยผู้เชี่ยวชาญด้านคลื่นเสียงความถี่สูง โดยใช้เครื่องตรวจคลื่นเสียงความถี่สูงตรวจผ่านทางช่องคลอด และทำการวิเคราะห์ข้อมูลหาความสัมพันธ์ของมุมระหว่างปากมดลูกกับมดลูก และอายุครรภ์*

ผลการวิจัย: *สตรีตั้งครรภ์ที่เข้าร่วมงานวิจัยทั้งหมด 249 คน ซึ่งมีสตรีตั้งครรภ์แต่ละช่วงอายุครรภ์อย่างน้อย 15 คน ผลงานวิจัยพบว่ามุมระหว่างปากมดลูกกับมดลูก ไม่มีความสัมพันธ์กับอายุครรภ์ที่เพิ่มขึ้นในช่วงอายุครรภ์ 16 0/7-24 6/7 สัปดาห์ (Pearson's correlation, r = 0.038, p = 0.553) และจากการวิเคราะห์แบบ linear regression พบว่าปัจจัยเดียวที่มีผลต่อมุมระหว่างปากมดลูกกับมดลูก คือ จำนวนการตั้งครรภ์ โดยพบว่าสตรีตั้งครรภ์หลังมีมุมระหว่างปากมดลูกกับมดลูกกว้างกว่าสตรีตั้งครรภ์แรกอย่างมีนัยสำคัญทางสถิติ (p < 0.001) ค่าเฉลี่ยของมุมระหว่างปากมดลูกกับมดลูก ± ส่วนเบี่ยงเบนมาตรฐาน ในสตรีตั้งครรภ์แรก และสตรีตั้งครรภ์หลัง คือ 96.1 ± 21.5 องศา และ108.9 ± 20.0 องศา ตามลำดับ*

สรุป: *มุมระหว่างปากมดลูกและมดลูกไม่สัมพันธ์กับอายุครรภ์ที่เพิ่มขึ้นในช่วงอายุครรภ์ 16-24 สัปดาห์ แต่พบว่ามุมระหว่างปากมดลูกและมดลูกมีความแตกต่างกันในสตรีตั้งครรภ์แรกและครรภ์หลัง*

คำสำคัญ: *มุมระหว่างปากมดลูกกับมดลูก, อายุครรภ์, การคลอดก่อนกำหนด*

Introduction

Preterm birth, which is defined as any birth before the completion of the 37 weeks of gestation, is one of the leading causes of perinatal and neonatal morbidity and mortality worldwide[1]. Accordingly, several attempts have been made from healthcare professionals around the world to determine the effective methods for early prediction and prevention of preterm birth; for examples include, risk categorization based on previous history of preterm birth, and the use of biochemical markers such as fetal fibronectin and short cervical length as common screening tools[2, 3]. The pregnancies that are associated with high risk of preterm birth can receive great benefit from certain preventative methods such as progesterone administration (both intramuscular injection and vaginal progesterone)[4], cervical pessary[5, 6] and cervical cerclage[7].

During pregnancy, there are many detectable anatomical changes that occur such as the increase in uterine size, fetal growth, the descent of amniotic sac, and the changes in tissue intrinsic factors. These changes are also associated with cervical softening, cervical shortening, cervical volume, and the uterocervical angle[8, 9]. Some anatomical changes may be predictive of spontaneous preterm birth. For example, Arabin et al demonstrated that preterm births can be prevented in cases of cervical insufficiency through the use of Arabin pessary. They suggested that the use of the pessary changes the inclination of the cervical canal, which can lead to a more acute uterocervical angle, thus decreasing direct pressure on internal os[10]. Accordingly, the assessment of the uterocervical angle may be predictive of preterm birth.

Currently, the transvaginal ultrasound between 16-24 weeks of gestation, which has led to the assessment of short cervical length, has been demonstrated to be a good predictor of preterm birth[11]. Its detection rate of possible spontaneous preterm birth before the completion of 34 weeks was 20-60%, depending on the design of each study[2, 11, 12]. Analogous to cervical length, other anatomical parameters such as the uterocervical angle may also be useful as a potential determination factor in the development of new predictive tools for spontaneous preterm birth. Recently, the anterior uterocervical angle (AUCA) has been introduced as a new parameter in the prediction of preterm birth. Sochacki-Wójcicka et al conducted a retrospective study to evaluate AUCA in women who spontaneously delivered preterm, and demonstrated that the risk of preterm delivery before 34 weeks increased with more obtuse AUCA[13]. These results were the same as those from a study by Dziadosz et al[14]. However, for clinical or research use of AUCA in predicting preterm birth, normal reference ranges of AUCA for each gestational week must first be created. Therefore, we conducted this study with the aim of determining the association between AUCA and gestational age, and to construct reliable reference ranges of AUCA as a function of gestational age, for cases of gestational age dependency.

Materials and Methods

This prospective descriptive cross-sectional study was conducted on Asian singleton pregnancies at gestational age between 16 0/7 and 24 6/7 weeks. This study was approved by the Ethics Committee of Rajavithi Hospital, Bangkok, Thailand. Pregnant women with access to the antenatal care clinic at the Department of Obstetrics and Gynecology, Rajavithi Hospital, Bangkok, Thailand, between July 1, 2017 and March 31, 2018 were recruited into the study with informed consent. The inclusion criteria were: 1) singleton pregnancy between 16 0/7 and 24 6/7 weeks of gestation; 2) accurate gestational age based on a reliable last menstrual period, along with a fetal biometry in the first half of pregnancy; and 3) low-risk pregnancies without any serious medical problems.

Women with history of spontaneous preterm birth, progesterone use, fetal anomalies, maternal medical complications such as diabetes mellitus and hypertension, history of cervical cerclage or cervical surgery, history of cervical cancer, abnormal vaginal bleeding, uterine structure abnormalities, infection or inflammation of the vagina or cervix, preterm delivery in the current pregnancy and loss to follow-up were all excluded from the study.

The AUCA is the angle between the cervix and the anterior lower uterine segment, which can be measured by transvaginal ultrasound. All ultrasound examinations were performed by the same well-trained sonographer to avoid interobserver variability, using Voluson S8 (GE ultrasound medical system) with a transvaginal 4-10 MHz transducer. The patients needed to completely empty their bladder before examination. The transvaginal probe was gently inserted into the anterior vaginal fornix. The image of the cervix was obtained at a midsagittal plane. The three best images per patient were selected and measured for AUCA. The AUCA was defined by the intersection of two lines, where the first line was drawn from the internal os to the external os, and the second line was drawn parallel to the anterior of the lower uterine segment crossing the internal os. The mean AUCA of the three best images of each woman was calculated and used for analysis. All women were followed-up until delivery. The perinatal outcomes were assessed for birth weight and gestational age at delivery. All data were collected and computerized for storage.

The appropriate sample size was determined using a formula for estimating an infinite population mass. The two-tail alpha-value was 0.05 ($Z\alpha$ /2= 1.96), the standard deviation (SD) was 26, which was applied from a study by Dziadosz et al[14], while the margin of error (D) was 3.5. At least 208 participants were included in the study; however, a final of 250 participants were required based on the 20% unexpected drop out.

The statistical analysis was performed using IBM SPSS version 21.0 (IBM SPSS Statistics for Windows, Release 2011. Armonk, NY: IBM Corp). The maternal baseline characteristics were reported using statistical mean, standard deviation and various percentages as appropriate. A regression analysis with Pearson's correlation was performed to determine the correlation between AUCA and gestational age. From the measurements, a p value < 0.05 was considered as statistically significant. In case a significant correlation was found, normal reference ranges of AUCA for each gestational week would be constructed.

Results

A total of 271 pregnant women were eligible during the study period. Twenty-two cases were excluded from the study because of loss of follow-up. Therefore, 249 uncomplicated singleton pregnant women were finally available for analysis. All of them met the criteria and attended antenatal care clinic at Rajavithi Hospital, between July 1, 2017 and March 31, 2018.

Of these 249 pregnant women, the mean (±SD) maternal age was 28.2±6.8 years, and the mean (±SD) BMI was 22.6±4.2 kg/m^2. About half of the participants were nulliparous (51.0%). Most of the babies were born by vaginal delivery (71.1%). The mean (±SD) gestational age at delivery was 38.7±1.2 weeks and the mean birth weight (±SD) was 3,098.4±386.7 g (Table 1).

The AUCA was measured at gestational period between 16 0/7 through 24 6/7 weeks, with at least 15 measurements per week. The mean AUCA of all pregnant women (±SD) was 102.3±21.7, while the mean AUCA for each gestational age is shown in Table 2. The intraobserver reliability score was calculated, and the intraclass correlation co-efficiency was 0.9 (95% CI, 0.91-0.94; p < 0.001). The association between AUCA and gestational age, based on regression analysis and Pearson's correlation, showed no statistical significance (r = 0.038, p = 0.553).

Table 1. The maternal baseline characteristics and the perinatal outcome.

Baseline characteristics	n = 249 (100%)
Age (years), mean ± SD	28.2 ± 6.8
BMI (kg/m^2), mean ± SD	22.6 ± 4.2
Nationality n (%)	
Thai	187 (75.1%)
Myanmar	41 (16.5%)
Cambodian	12 (4.8%)
Laos	9 (3.6%)
Parity n (%)	
Nulliparity	127 (51.0%)
Multiparity	122 (49.0%)
Smoking n (%)	2 (0.8%)
Cervical length (cm), mean±SD	4.4 ± 1.0
Route of delivery n (%)	
Vaginal delivery	177 (71.1%)
Cesarean section	72 (28.9%)
Gestational age at delivery (weeks), mean±SD	38.7 ± 1.2
Birth weight (g), mean±SD	3,098.4 ± 386.7

BMI: body mass index, SD: standard deviation

Table 2. The mean and standard deviation of the anterior uterocervical angle for each gestational age between 16 0/7 - 24 6/7 weeks.

Gestational age (weeks)	n	Mean	SD
16 0/7 - 16 6/7	19	102.3	24.2
17 0/7 - 17 6/7	27	97.6	23.2
18 0/7 - 18 6/7	59	102.2	20.5
19 0/7 - 19 6/7	32	105.3	25.6
20 0/7 - 20 6/7	34	102.4	20.1
21 0/7 - 21 6/7	22	99.2	23.0
22 0/7 - 22 6/7	25	107.3	25.2
23 0/7 - 23 6/7	16	98.1	19.4
24 0/6 - 24 6/7	15	105.4	15.5

SD: standard deviation

The univariate and multivariate analysis demonstrated that the increase in gestational age was not related to changes in AUCA, and neither were advanced maternal age, BMI of more than 30 kg/m^2, smoking, changes in cervical length, gestational age at delivery, or birth weight. The only significant factor that was found to be associated with changes in AUCA was the parity. The multiparity group were found with more obtuse AUCA than the nulliparity group, with statistical significance (the mean difference was 12.8 degrees, 95%CI 7.6-18.0, p<0.001) (Table 3). The mean (±SD) angles were 96.1±21.5 degrees and 108.9±20.0 degrees in the nulliparity and multiparity groups, respectively. This study found that 44.9% of pregnant women who delivered at term had AUCA > 105 degrees.

Table 3. The univariate and multivariate analysis in associating the demographic data and the anterior uterocervical angle.

Variables	AUCA		Univariate analysis			Multivariate analysis		
	Mean	(SD)	Crude MD	95%CI	p value	Adjusted MD	95%CI	p value
Gestational age (weeks)	102.3	21.7	0.4	- 0.8, 1.6	0.545	0.2	- 0.9, 1.4	0.687
Age (years)								
< 35	100.9	21.7	Ref.					
≥ 35	106.6	21.4	2.9	- 0.3, 6.0	0.075			
BMI (kg/m^2)								
< 30	102.3	21.9	Ref.					
≥ 30	102.4	18.4	0.0	- 12.6,12.7	0.996			
Parity (%)								
Nulliparity	96.1	21.5	Ref.					
Multiparity	108.9	20.0	12.8	7.6,18.0	< 0.001	12.8	7.6,18.0	< 0.001
Smoking								
No	102.4	21.8	Ref.					
Yes	92.1	14.1	-10.3	- 40.7, 20.1	0.505			
Cervical length (cm)	102.3	21.7	3.0	0.3, 5.7	0.033	3.0	-0.8,1.6	0.480
Gestational age at delivery (weeks)	102.3	21.7	0.2	- 2.1, 2.6	0.846			
Birth weight (g)	102.3	21.7	0.0	- 0.0, 0.0	0.780			

AUCA: anterior uterocervical angle, SD: standard deviation, MD: mean difference, CI: confidence interval, BMI: body mass index

Discussion

The anterior uterocervical angle (AUCA) is now being used as a new predictor of spontaneous preterm birth with a good sensitivity[14], especially when used together with cervical length. However, for clinical use, we have aimed to develop normal reference ranges of AUCA for comparative purposes. We have hypothesized that AUCA may increase with advancing gestational age. Therefore, we conducted this study to answer the hypothesis and to construct normal reference ranges of AUCA for each gestational week, for cases where AUCA was gestational age dependent. However, in contrast to the hypothesis, this study demonstrated that AUCA was not significantly related to advancing

gestational age (16-24 weeks). Therefore, we could not establish the normal reference ranges for each gestational week. Interestingly however, the AUCA of the nulliparous women was significantly different from that of the multiparous women. Thus, based on the observations, we instead proposed the use of AUCA values specific to parity in clinical practices.

Based on a previous study reported by Dziadosz et al, the uterocervical angle ≥ 95 degrees and ≥ 105 degrees was a significant predictor of spontaneous preterm birth before the completion of 37 weeks and 34 weeks, respectively, with a sensitivity level of about 80%[14]. Likewise, a study by Farràs Llobet A et al showed that 33.7% of women who had anterior uterocervical angle > 105 degrees delivered at term[15]. However, our study found that 44.9% of pregnant women who delivered at term had AUCA > 105 degrees. This difference in results compared with our study may possibly be explained by the difference in population characteristics such as body or pelvic parameters[16]. Therefore, the cutoff point of the AUCA used for predicting preterm birth should be based on the normal values created for its own population. From this study, the mean (± SD) anterior uterocervical angle that could be used as a predictor for spontaneous preterm birth in Asian women of gestational age between 16 0/7-24 6/7 weeks should be 102.3 ± 21.7 degrees.

As mentioned above, the interesting insight gained from this study was that AUCA was significantly wider among multiparous women, when compared to that of nulliparous women. This might be explained by the fact that, during pregnancy, the uterus becomes enlarged, and the ligaments are stretched to support the growing uterus, which then becomes weakened. The prior delivery processes can cause permanent changes in pelvic floor or an incomplete recovery. As a result, the uterus often becomes retroverted after the delivery of the baby[17-19]. Because of the difference in AUCA in accordance with the parity, the clinical application of AUCA in predicting spontaneous preterm birth must take the parity into account, with the normal values for the parity being used separately. The mean (±SD) anterior uterocervical angles were 96.1 ± 21.5 degrees and 108.9 ± 20.0 degrees in nulliparous and in multiparous women, respectively.

The strengths of this study included: 1) prospective nature of the study, specifically designed to measure the uterocervical angle in pregnant women between 16 0/7 and 24 6/7 weeks of gestation, and 2) a single well-trained operator was used in order to avoid interobserver variability. The limitations of our study were as follows: 1) there had been no comparison of AUCA in the same woman between different gestational weeks, which could more clearly show the association between gestational age and uterocervical angle; and 2) a lack of information about the position of the uterus before pregnancy. Fundamentally, the changes in AUCA during pregnancy may depend on the AUCA angle before pregnancy. The normal position of a non-pregnant uterus could be anteverted, anteflexed, retroverted or retroflexed[20, 21]. In most women, the uterus lies anteverted and anteflexed. We hypothesized that the differences in the angle among pregnant women at the same gestational age may be caused by a neutral positioning of the uterus before pregnancy or a pathologic condition such as pelvic endometriosis. In order to prove this hypothesis, further studies would be needed.

Conclusion

In conclusion, the anterior uterocervical angle at 16-24 weeks was gestational-age independent; however, based on observation, it was significantly related to the parity. The normal values according to parity were provided, and they could potentially be used in determining the risk of preterm birth, but further confirmatory studies for the usefulness are required. Because of its gestational period independency, AUCA may be superior to other parameters such as cervical length in terms of simplicity in clinical use.

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Potential conflicts of interest

The authors declare no conflict of interest.

References

1. WHO Recommendations on Interventions to Improve Preterm Birth Outcomes. WHO Guidelines Approved by the Guidelines Review Committee. Geneva 2015.
2. Celik E, To M, Gajewska K, Smith GC, Nicolaides KH, Fetal Medicine Foundation Second Trimester Screening G. Cervical length and obstetric history predict spontaneous preterm birth: development and validation of a model to provide individualized risk assessment. Ultrasound Obstet Gynecol 2008;31:549-54.
3. Goldenberg RL, Goepfert AR, Ramsey PS. Biochemical markers for the prediction of preterm birth. Am J Obstet Gynecol 2005;192(5 Suppl):S36-46.
4. Elimian A, Smith K, Williams M, Knudtson E, Goodman JR, Escobedo MB. A randomized controlled trial of intramuscular versus vaginal progesterone for the prevention of recurrent preterm birth. Int J Gynaecol Obstet 2016;134:169-72.
5. Jin Z, Chen L, Qiao D, Tiwari A, Jaunky CD, Sun B, et al. Cervical pessary for preventing preterm birth: a meta-analysis. J Matern Fetal Neonatal Med 2019;32:1148-54.
6. Zheng L, Dong J, Dai Y, Zhang Y, Shi L, Wei M, et al. Cervical pessaries for the prevention of preterm birth: a systematic review and meta-analysis. J Matern Fetal Neonatal Med 2019;32:1654-63.
7. Govindaswami B, Jegatheesan P, Nudelman M, Narasimhan SR. Prevention of Prematurity: Advances and Opportunities. Clin Perinatol 2018;45:579-95.
8. House M, Bhadelia RA, Myers K, Socrate S. Magnetic resonance imaging of three-dimensional cervical anatomy in the second and third trimester. Eur J Obstet Gynecol Reprod Biol 2009;144 Suppl 1:S65-9.
9. Myers KM, Feltovich H, Mazza E, Vink J, Bajka M, Wapner RJ, et al. The mechanical role of the cervix in pregnancy. J Biomech 2015;48:1511-23.
10. Arabin B, Alfirevic Z. Cervical pessaries for prevention of spontaneous preterm birth: past, present and future. Ultrasound Obstet Gynecol 2013;42:390-9.
11. Son M, Miller ES. Predicting preterm birth: Cervical length and fetal fibronectin. Semin Perinatol 2017;41:445-51.
12. Guzman ER, Walters C, Ananth CV, O'Reilly-Green C, Benito CW, Palermo A, et al. A comparison of sonographic cervical parameters in predicting spontaneous preterm birth in high-risk singleton gestations. Ultrasound Obstet Gynecol 2001;18:204-10.
13. Sochacki-Wojcicka N, Wojcicki J, Bomba-Opon D, Wielgos M. Anterior cervical angle as a new biophysical ultrasound marker for prediction of spontaneous preterm birth. Ultrasound Obstet Gynecol 2015;46:377-8.
14. Dziadosz M, Bennett TA, Dolin C, West Honart A, Pham A, Lee SS, et al. Uterocervical angle: a novel ultrasound screening tool to predict spontaneous preterm birth. Am J Obstet Gynecol 2016;215:376 e1-7.
15. Farras Llobet A, Regincos Marti L, Higueras T, Calero Fernandez IZ, Gascon Portales A, Goya Canino MM, et al. The uterocervical angle and its relationship with preterm birth. J Matern Fetal Neonatal Med 2018;31:1881-4.
16. Zarate-Kalfopulos B, Romero-Vargas S, Otero-Camara E, Correa VC, Reyes-Sanchez A. Differences in pelvic parameters among Mexican, Caucasian, and Asian populations. J Neurosurg Spine 2012;16:516-9.
17. Diniz CP, Araujo Junior E, Lima MM, Guazelli CA, Moron AF. Ultrasound and Doppler assessment of uterus during puerperium after normal delivery. J Matern Fetal Neonatal Med 2014;27:1905-11.
18. Mulic-Lutvica A, Bekuretsion M, Bakos O, Axelsson O. Ultrasonic evaluation of the uterus and uterine cavity after normal, vaginal delivery. Ultrasound Obstet Gynecol 2001;18:491-8.
19. van Veelen GA, Schweitzer KJ, van der Vaart CH. Ultrasound imaging of the pelvic floor: changes in anatomy during and after first pregnancy. Ultrasound Obstet Gynecol 2014;44:476-80.
20. Nizic D, Pervan M, Kos I, Simunovic M. Flexion and version of the uterus on pelvic ultrasound examination. Acta Med Croatica 2014;68:311-5.
21. Sosa-Stanley JN, Bhimji SS. Anatomy, Pelvis, Uterus. In: StatPearls (Internet); StatPearls Publishing LLC: Treasure Island, FL, USA, 2018. Available online: https://www.ncbi.nlm.nih.gov/books/NBK470297/(accessed on 4 July 2018).