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Original Article

The predictive role of transperineal ultrasound measuring anterior uterocervical angle and cervical length on preterm birth

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Abstract: *Objective:* This study aims to explore the possibility and value of the anterior uterocervical angle (ACA) and cervical length on the prediction of preterm birth in second trimester using the transperineal ultrasound. *Methods:* A total of 1064 cases of single birth primiparas undergoing prenatal ultrasonographic evaluation in Wuxi People's Hospital Affiliated to Nanjing Medical University from January 2016 to December 2016 were enrolled. The ACA and cervical length of these pregnancies were measured in the second trimester (between 22-24 weeks gestation) by the transperineal ultrasound. The pregnant women were divided into preterm group and mature group according to the pregnancy outcomes. *Results:* There were 84 cases in the preterm group (78.9%, 84/1064) and 980 cases in the mature group (92.11%, 980/1064), respectively. The mean ACA and cervical length of preterm group were 112.48° ± 15.83° and 30.94 ± 6.32 mm, while they were 103.52° ± 13.78 and 37.28 ± 6.74 mm in the mature group ($P < 0.05$). Multivariate logistic regression analysis demonstrated that ACA (OR = 7.642, $P < 0.05$) and cervical length (OR = 4.154, $P < 0.05$) were the risk factor of preterm. The area under ROC curve of the ACA was 0.882 and of the cervical length was 0.664. The corresponding cutoff values of ACA and cervical length in predicting preterm birth were 113° and 27 mm, with the sensitivity, specificity, PPV, NPV, and validity at 86.9%, 75%, 22.96%, 98.53%, 75.94%, and 71.43%, 62.14%, 13.92%, 96.21%, 62.66%, respectively. *Conclusions:* The ACA is an objective and effective indicator to predict preterm birth in the second trimester measured by transperineal ultrasound. The diagnostic value of measuring the ACA was better than that of measuring the cervical length in the same period.

Keywords: Anterior uterocervical angle, preterm birth, ROC curve

Introduction

Prevention of preterm birth control is an important task in the perinatal medicine. Cervical length has remained the only most widely adopted predictive morphologic measurement [1-3]. For a long time, new diagnostic methods are tried to predict preterm births. Nicole Sochacki-Wojcicka proposed a new concept anterior uterocervical angle (ACA) referring to the angle between the line of internal cervix and lower segment of anterior uterine wall and the ligature between internal and external cervix [4]. Previous investigations of ACA indicate that it may be a useful parameter to monitor the progression of the cervix towards a labor phenotype [5]. Transperineal ultrasound can clearly show the pelvic floor structure clearly by placing the probe at the perineum. It can replace the vaginal ultrasound during the medium and late pregnancy [6, 7]. Ultrasonic measurement of cervix length is the most commonly used method to predict premature birth featured as gradual change, easy to operate, and high sensitivity and specificity [8, 9]. The purpose of this study is to measure pregnant metaphase ACA and cervical length by transperineal ultrasound to explore the predictive value of ACA in preterm birth.

Materials and methods

Object of study

A total of 1064 cases of single birth primiparas undergoing prenatal ultrasonographic evalua-

Table 1. Demographic data are n (± SD) or n (%)

	Mature group (n = 980, 92.11%)	Preterm group (n = 84, 7.89%)	*P* value
Mean maternal age, y	28.4 (± 4.3)	28.7 (± 4.9)	0.86
Nulliparous	641 (65.41%)	52 (59.52%)	0.67
Prior spontaneous preterm birth	64 (6.53%)	17 (20.24%)	0.005
Natural conception	903 (92.14%)	78 (92.86%)	0.91
Tobacco use	10 (1.02%)	1 (1.19%)	0.89

CL, cervical length; LEEP, loop electrosurgical excision procedure; ACA, Anterior uterocervical angle.

Table 2. Clinical features data are n (± SD) or n (%)

	Mature group (n = 980, 92.11%)	Preterm group (n = 84, 7.89%)	*P* value
Prior dilation and curettage	189 (19.29%)	26 (30.95%)	0.01
Prior cervical conization	7 (0.71%)	2 (2.4%)	0.14
Prior cervical LEEP	49 (5%)	5 (5.95%)	0.82
Abnormal pap smear	217 (22.14%)	18 (21.43%)	0.65
Transperineal cervical length, mm	37.28 (± 6.74)	30.94 (± 6.32)	< 0.01
Transperineal ACA°	98.52° (± 13.78°)	112.48° (± 15.83°)	< 0.01
Mean body mass index at conception, Kg/m^2	22.73 (± 5.37)	26.47 (± 6.25)	< 0.01
Gestational weight gain, Kg	14.6 ± 5.6	15.9 ± 7.3	0.17
Gestational diabetes	63 (6.43%)	10 (11.90%)	0.08
Hypertension	110 (11.22%)	14 (16.67%)	0.32
Cesarean delivery, primary	302 (30.82%)	46 (54.76%)	< 0.01
Male infant	541 (55.20%)	47 (55.95%)	0.86
NICU admission	100 (10.20%)	54 (64.29%)	< 0.01

CL, cervical length; LEEP, loop electrosurgical excision procedure; ACA, Anterior uterocervical angle.

tion in Wuxi People's Hospital Affiliated to Nanjing Medical University from January 2016 to December 2016 were enrolled, with mean age at 27.5 ± 2.7 (21-33) years old.

Inclusion criteria: first natural impregnation with a single pregnancy, successful measurement of the length of the ACA and cervix, and the outcome of the pregnancy. Exclusion criteria: a history of miscarriage, hydramnios, placenta disease, cervical insufficiency, severe dysplasia of uterus, and other severe diseases.

Measurement

The ACA and cervical length of these pregnancies were measured in the second trimester (between 22-24 weeks gestation) by the transperineal ultrasound Philips iU-22 and GE Voluson E8. The probe frequency was 3.5-5 MHz and the bladder capacity was 50-100 ml. The patient was set at lithotomy position and the probe was used to scan above the perineum. Two aspects of data were measured by three sonographers, including ACA as the angle between the line of internal cervix and lower segment of anterior uterine wall and the ligature between internal and external cervix, and cervical length as the distance between internal and external cervix. Each measurement was repeated for three times. The parameter was remeasured when the measuring error over 5° in ACA and 5 mm in cervical length.

The delivery time of pregnant women was collected according to the medical record. The delivery pregnancy week was determined by the combination of the last menstrual period and early pregnancy ultrasound. Preterm birth was defined as pregnancy between 28 and 37 weeks. All the preterm birth in this study were spontaneous.

Statistical analysis

All data analyses were performed on SPSS 16.0 software. The measurement data were presented as mean ± standard deviation and compared by t test. The enumeration data were

Figure 1. ACA measured by transperineal ultrasound.

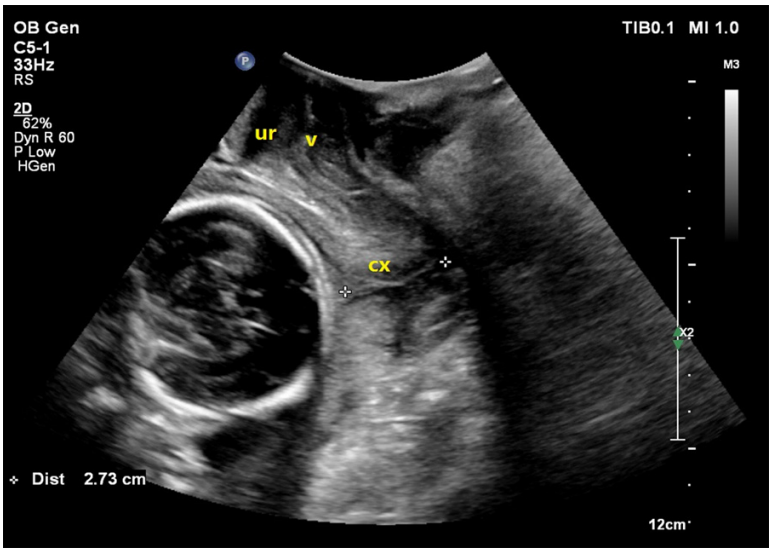

Figure 2. Cervical length measured by transperineal ultrasound. CX, internal cervix; UR, bladder.

analyzed by chi-square test. Multivariate logistic regression analyses were performed to identify the contribution of ACA and cervical length to preterm. $P < 0.05$ was depicted as statistical significance. Receiver operating characteristic (ROC) curve was analyzed by Mann-Whieney method to calculate area under curve (AUC).

Results

General information

A total of 1064 pregnant women were enrolled in this study, with mean age at 27.5 ± 2.5 (21-33) years old. There were 84 cases in the preterm group (78.9%, 84/1064) and 980 cases in the mature group (92.11%, 980/1064), respectively. No statistical significance was found on age, childbearing history, fertilization, smoking, cervical surgery history, gestational diabetes mellitus, and maternal hypertension between two groups. Compared with mature group, the preterm group exhibited significantly higher possibility of premature birth, dilation and curettage history, and cesarean section history ($P < 0.05$). The mean ACA in preterm group was 112.48° ± 15.83° (94°-135°), which was significantly larger than that of ACA in mature group as 98.52° ± 13.78° ($P < 0.05$). On the contrary, the cervical length was 30.94 ± 6.32 (15-37) mm in preterm group, which was obviously shorter than that in mature group as 37.28 ± 6.74 (21-45) mm ($P < 0.05$) (**Tables 1-2**, **Figures 1-2**).

The contribution of ACA and cervical length to preterm

Multivariate logistic regression analysis was adopted to identify the risk of ACA and cervical length to preterm. It was showed that ACA measurement through perineum was the risk factor of preterm (OR = 7.642, 95% CI = 2.748-21.021, $P < 0.05$). Larger ACA angle indicated higher preterm rate. Cervical length measured through perineum was also a risk factor of preterm (OR = 4.154, 95% CI = 1.294-17.771, $P < 0.05$). Shorter cervical length suggested higher preterm rate.

ROC curve analysis revealed that the AUC of ACA (**Figure 3A**) in predicting premature birth was 0.882, and the best critical value was 113° with sensitivity at 86.9% and specificity at 75.0%. The AUC of cervical length (**Figure 3B**) in predicting premature birth was 0.664,

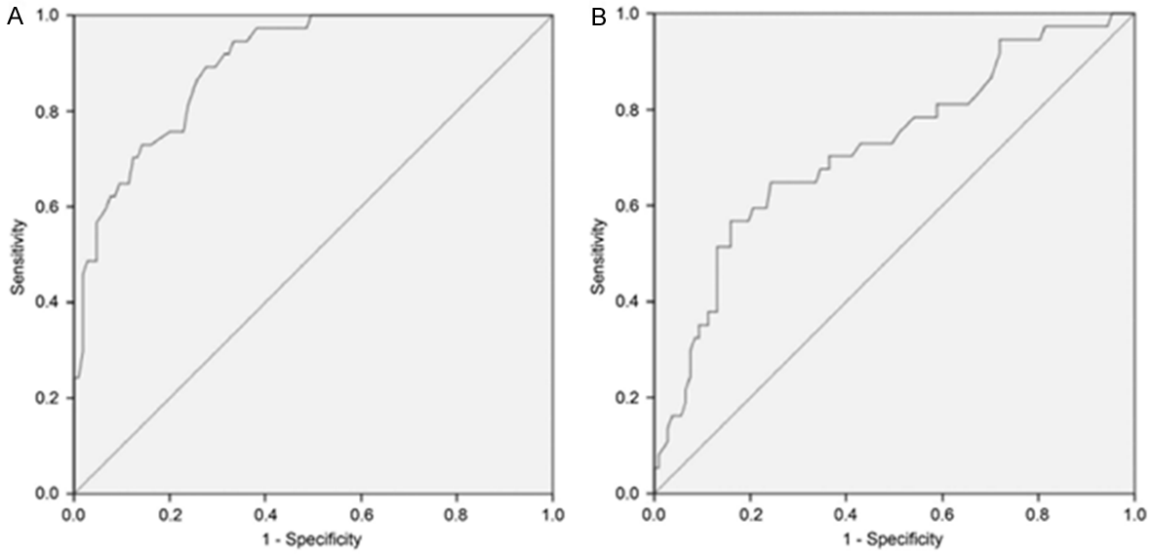

Figure 3. ROC curve of ACA and cervical length in predicting premature birth. A. ACA; B. cervical length.

Table 3. Best cut-off value analysis of ACA and cervical length in mature group and preterm group

	Term group (n = 980)		Preterm group (n = 84)		Cut-off value
	> Cut-off value	< Cut-off value	> Cut-off value	< Cut-off value	
ACA (°)	245 (25%)	735 (75%)	73 (86.90%)	11 (13.10%)	113
Cervical length (mm)	609 (62.14%)	371 (37.86%)	24 (28.57%)	60 (71.43%)	27

Table 4. Performance analysis of ACA and cervical length in predicting preterm birth

	AUC (95% *CI*)	Cut-off value (mm)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
ACA (°)	0.882 (0.791~0.925)	113	86.90	75.00	22.96	98.53	75.94
Cervical length (mm)	0.664 (0.628~0.692)	27	71.43	62.14	13.92	96.21	62.66

and the best critical value was 27 mm with sensitivity at 71.43% and specificity at 62.14% (**Tables 3**-**4**).

Discussion

The predictive value of ultrasound during pregnancy attracts more and more attention [8, 10]. As one of the predictors of premature birth upon evidence-based medicine, cervical length has been included as an important indicator of cervical evaluation [11-14]. ACA is a new concept in predicting premature birth that was firstly proposed by Nicole Sochacki-Wójcicka. However, there was still lack of large scale prospective study [4]. This research tested the diagnostic efficiency of ACA and cervical length in mid-tremister from more than 1000 cases using transperineal ultrasound, aiming to explore the predictive value of ACA on premature birth.

At present, there are three ways to measure the cervix using ultrasound, including through vagina, abdomen, and perineum. The common advantage of the latter two methods is that the probe does not enter the vagina, thus is more acceptable. However, the visible rate of cervix through abdomen is only about 46% under the circumstance of bladder not filling. Furthermore, bladder filling artificially extends the cervical length, which seriously affects the measurement accuracy [15]. Vaginal measurement does not require filling the bladder and exhibits high visible rate of cervix, whereas may increase the risk of infection and preterm birth. Cicero S *et al.* [16] measured the cervical length using ultrasound through vagina, abdomen,

and perineum, compared the data with colposcope, and considered that the result of transperineal ultrasound was similar to that of colposcope with error smaller than 5 mm. Though Nicole Sochacki-Wojcicka *et al.* tested ACA using transvaginal ultrasound, it is not recommended to apply transvaginal ultrasound in pregnant metaphase in China. This study used transperineal ultrasound to measure ACA and cervical length. The results showed that the morphology of cervix can be clearly detected under suitable filling bladder without inducing obvious discomfort.

The physical and mechanical foundation of ACA angle changes in predicting preterm birth bases on the pressure of pregnant women pelvic viscera and increased fetus on internal cervix. The amniotic fluid volume usually above 1000 ml in late pregnancy, and the pressure was larger during standing. Blunt ACA will give the internal cervical os more direct pressure, leading to internal cervical os expansion. On the contrary, sharp ACA will make the lower wall of the uterus form a "inverted triangle care" to hold the pressure from the top, thereby reducing the pressure and maintaining the normal shape [17-19]. Nicole Sochacki-Wójcicka reported that ACA angle changed following the gestational weeks increase, which may be related to the increase of the fetus. This study investigated the pregnant women at 22-24 gestational weeks, aiming to use middle gestational period ACA measurement to predict preterm birth.

In this study, the average length of the cervix in the preterm group was significantly different from that in the mature group ($P < 0.05$), which was similar with previous study. Temporary LA followed up pregnant women at 17-23 gestational weeks and found the optimal cut-off value of the length of the cervix for predicting preterm birth was 26 mm, which was similar to 27 mm in our results [14]. Dziadosz M *et al.* predicted was 81% with ACA = 95° for the sensitivity of preterm birth < 34 weeks, and 80% with ACA = 105° for the sensitivity of preterm birth < 37 weeks [20]. Nicole Sochacki-Wójcicka's suggested that the predictive sensitivity of preterm birth was 66.7% with ACA = 107° in the second trimester of pregnancy. Our results presented that the predictive sensitivity was 86.90% for ACA = 113° in the second trimester of pregnancy. Since ACA angle measurement was closely related to factors such as gestational weeks, race, and previous history, which led to differences in the best critical points calculation, predictive ACA angle for premature birth was between 105°-113°. In order to verify the predictive efficacy of ACA in predicting preterm birth, the AUC was 0.882 for ACA and 0.664 for the cervical length. In addition, the sensitivity and specificity for best critical value of ACA and cervical length was 86.9%, 71.43%, 75% and 62.14%, respectively. It indicated that transperineal ultrasound measurement of ACA in the middle gestational period showed better diagnostic value than cervical length measurement in the same period for the prediction of preterm birth. However, limited sample size and single center study made the selection and calculation of best cut-off value inaccuracy. Multi-center larger size research may help construct the normal reference range of ACA in the second trimester.

In conclusion, compared with the length of the cervix, ACA in the second trimester of pregnancy is a sensitive and specific detection method for the prediction of preterm birth. It is worth of promotion because of its objective and effective.

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Disclosure of conflict of interest

None.

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