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The prediction of preterm birth threat by uterocervical angle

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Abstract

Objective: Preterm birth is the most significant reason for newborn mortality and morbidity, and it is possible to achieve positive neonatal outcomes by early diagnosis and treatment. In our study, we aimed to investigate the efficiency of uterocervical angle (UCA) measurement for the prediction of preterm birth.

Methods: A total of 82 singleton pregnant women who admitted to our emergency maternity ward with pain complaint between 24 and 34 weeks of gestation were included in this prospective empirical study. Age, last menstrual period, week of gestation, gravida, parity, abortion, preterm labor history, previous cervical surgery, body mass index, presence of chronic disease, and smoking habit of each pregnant woman were investigated, their Bishop scores were calculated, and cervical length and UCA measurements were performed by transvaginal ultrasound examination under optimal conditions. The patients were discharged after observation, examination and treatment processes. After the delivery, the week of gestation, delivery type, newborn's birth weight, sex and the need for intensive care unit were investigated.

Results: Among the etiological factors, only the multiparity and abortion history were found significantly high in pregnant women who had preterm delivery. The cut-off value for UCA measurements was determined 80.5°. The rate of UCA >80.5° in women who delivered before 37 weeks of gestation was found 75%, and it was significantly higher than the term cases (p=0.007). For this value, it was found that UCA sensitivity was 75%, selectivity was 58%, positive prediction value was 53% and negative prediction value was 77%.

Conclusion: In consideration of our findings, uterocervical angle measurement over 80.5° poses a high risk for deliveries before 37 weeks of gestation, and it provides a higher diagnostic performance than cervical length measurement and Bishop scoring.

Keywords: Cervical length, preterm birth threat, uterocervical angle.

Özet: Uteroservikal açının erken doğum tehdidinde öngörüsü

Amaç: Preterm doğum yenidoğan mortalite ve morbiditesinin en önemli sebebi olup erken tanı ve tedavi ile olumlu neonatal sonuçlar almak mümkündür. Çalışmamızda preterm doğum öngörüsünde uteroservikal açı (UCA) ölçümünün etkinliğini incelemeyi amaçladık.

Yöntem: Acil doğum servisimize sancı şikayeti ile başvuran 24–34. gebelik haftasında bulunan 82 tekil gebe bu prospektif gözlemsel nitelikteki çalışmaya dahil edildi. Her bir gebenin yaş, son adet tarihi, gebelik haftası, gravide, parite, abortus, preterm doğum öyküsü, geçirilmiş servikal cerrahi, vücut kitle indeksi, kronik hastalık varlığı, sigara kullanımı sorgulandı, Bishop skoru hesaplandı, transvajinal ultrason ile servikal uzunluk ölçümü ve UCA ölçümü optimal şartlarda yapıldı. Hastalar gözlem, tetkik ve tedavi sürecinin sonunda taburcu edildi. Doğum sonrasında ise gebelik haftası, doğum şekli, yenidoğanın doğum kilosu, cinsiyeti ve yoğun bakım ihtiyacı sorgulandı.

Bulgular: Etiyolojik faktörlerden yalnız multiparite ve abortus öyküsü preterm doğum yapan gebelerde anlamlı olarak yüksek bulundu. UCA ölçümleri için kesim noktası 80.5° olarak saptandı. 37. gebelik haftası öncesi doğum yapan kadınlarda UCA'nın >80.5° olma oranı %75 bulundu ve term doğum yapanlara göre anlamlı olarak yüksek bulundu (p=0.007). Bu nokta için UCA duyarlılığı %75, seçiciliği %58, pozitif kestirim değeri %53 ve negatif kestirim değeri %77 saptandı.

Sonuç: Bulgularımız ışığında 80.5°'nin üzerinde uteroservikal açı ölçümü 37 hafta öncesi doğumlar için yüksek bir risk öngörmektedir ve servikal uzunluk ölçümü ve Bishop skorlamasından daha yüksek bir tanısal performans ortaya koymaktadır.

Anahtar sözcükler: Uteroservikal açı, erken doğum tehdidi, servikal uzunluk.

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Introduction

Preterm birth is the most significant reason determining perinatal mortality and morbidity of fetus without any anomaly.[1] Apart from congenital malformations, prematurity accounts for 75–90% of newborn deaths.[2] According to the data of World Health Organization (WHO), approximately 15 million babies are born preterm (<37 weeks of gestation) every year, and this is equal to one in 10 live births. In living newborns, the risk of sequel associated with prematurity is high.[2] Every year, approximately one million children die due to the preterm birth complications, and most of the surviving children have visual and hearing problems and maintain their lives with mental or physical disabilities.[1]

Measuring cervical length by ultrasonography has become a routine practice today as an objective and non-invasive method to evaluate the preterm labor. With this method, apart from cervix length, it is possible to do structural and functional evaluations such as condition and appearance of internal os (i.e. its funneling), cervical dilatation together with membrane herniation, and cervical responses to uterine contractions and fundal pressure. Either necessarily or unnecessarily, the treatments of many pregnant women who admit emergency maternity units are carried out without distinguishing false/ineffective or actual/effective contractions. Our aim in this study is to report differences between patients admitted to emergency clinic who undergo actual labor and those undergo false labor by uterocervical angle (UCA) measurement aside from cervix length, and preterm labors carried out in association with it and related gestational outcomes.

Methods

The format of our study was planned as prospective empirical study and the ethics committee approval no. 26817412 dated 19.07.2016 was obtained.

The inclusion criteria for singleton live pregnancy cases who admitted to the emergency maternity clinic of our hospital between July 2016 and January 2017 with pain/contraction complaints and who were between 24 and 34 weeks of gestation were as below:

- Two and more regular uterine contractions in 10 minutes
- Labor not being on active phase (dilatation <4 cm, effacement <80%)
- No history of cervical cerclage in previous weeks of gestation

In the cases of chorioamnionitis, ablatio placentae, fetal distress, presence of fetal anomaly, placenta previa condition or the conditions requiring maternal and fetal emergency cases, the patients were excluded from the study.

After the initial examination and contraction treatment and tocolysis at the emergency maternity unit, the patients were hospitalized in our perinatology clinic or they were followed up through the polyclinic after discharging them when they contractions ended.

Accordingly, 82 cases were included in the study in the related period. Following the medical and obstetric histories of the patients meeting the criteria, cervical dilatation, effacement, position, viscosity and the level of the incoming part of fetus were evaluated for Bishop score during gynecological examination. The pregnant women were evaluated by transvaginal sonography on lithotomy position when the bladder was empty. To ensure the standardization, all measurements were carried out by the same physician (OB). The cervical length measurement was done through sagittal plane of cervix, in a section where also internal os, external os, cervical canal and endocervical mucosa could be displayed, by enlarging the image as covering 3/4 of the screen. Also, in cases where the length between internal os and external os was not on a single line, the measurement was done as linear sections and total cervical length was obtained. The measurement was carried out three times, and the shortest length with the best image quality was recorded for each pregnant woman.

Uterocervical angle is the angle measured on the triangle which is between the anterior uterine segment and cervical canal. For this, certain straight lines should be obtained; first straight line was drawn through endocervical canal between internal os and external os. The first line drawn between internal os and external os was considered a straight line even though cervical canal was curved. The second line was drawn ideally 3 cm from internal os through anterior uterine segment. In this way, the angle obtained between two straight lines was considered as UCA (**Fig. 1**). In shape changes (Y- or U-like shape changes) corresponding to the early periods of funneling or the dilatation, cervical canal measurement between them was also considered as first straight line. The line drawn from the innermost point of cervical canal to anterior uterine segment was considered as the second straight line and the angle was measured (**Fig. 2**).

After the initial examination and contraction treatment and tocolysis at the emergency maternity unit, the patients were hospitalized and monitored in our perinatology clinic of our hospital. Depending on the ending of contractions, the patients were discharged and followed up through the polyclinic and their follow-up data were completed upon the delivery. Accordingly, the pregnant women were assessed in 2 groups which were those delivered before (study group) and after (control group) 37 weeks of gestation. Delivery type, week of gestation during delivery, newborns' birth weight, sex, newborns' need for intensive care unit and betamethasone doses of all pregnant women who delivered were evaluated according to their own groups.

For statistical analysis, IBM SPSS Statistics 22 (IBM SPSS, Istanbul, Turkey) was used. Conformity of the study parameters to normal distribution was evaluated by Shapiro-Wilk test. For comparing descriptive statistical methods (mean, standard deviation, frequency) when evaluating study data, Student t test was used in the two-group comparison of parameters displaying normal distribution, and Mann-Whitney U test was used in the two-group comparison of parameters not displaying normal distribution. For the comparison of qualitative data, chi-square test, Yates' correction for continuity and Fisher's exact chi-square were used. ROC curve was used to evaluate diagnostic performance levels of uterocervical angle measurements to distinguish those undergoing preterm labor. The significance level was considered $p<0.05$.

Results

In line with the method followed, a study group consisting of 32 pregnant women who were hospitalized and treated and delivered at <37 weeks of gestation and a control group consisting of 50 pregnant women who delivered ≥37 weeks of gestation were established.

It was found that gravida, parity, abortion and normal delivery numbers in pregnant women, whose weeks of gestation during delivery were <37, were higher than the pregnant women who were in the control group and whose weeks of gestation during delivery were ≥37, and this difference was statistically significant ($p<0.05$ and $p<0.001$) (**Table 1**). There was no statistically significant difference in terms of age, body mass index (BMI), preterm labor history, smoking habit among both groups and between the patients who found to have hypertension and gestational diabetes.

As expected, newborns' birth weight and newborns' need for intensive care unit were higher in patients who underwent preterm labor. The data on the delivery weeks, birth weights, delivery types and postnatal outcomes are presented in **Table 2**.

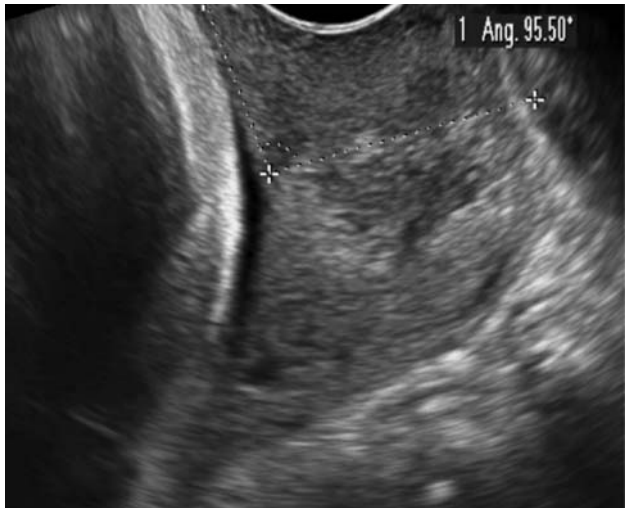

Fig. 1. Uterocervical angle is drawn in the triangle area between anterior uterine segment cervical canal, ideally for 3 cm where first line is drawn through endocervical canal between internal os and external os and second line from internal os through anterior uterine segment.

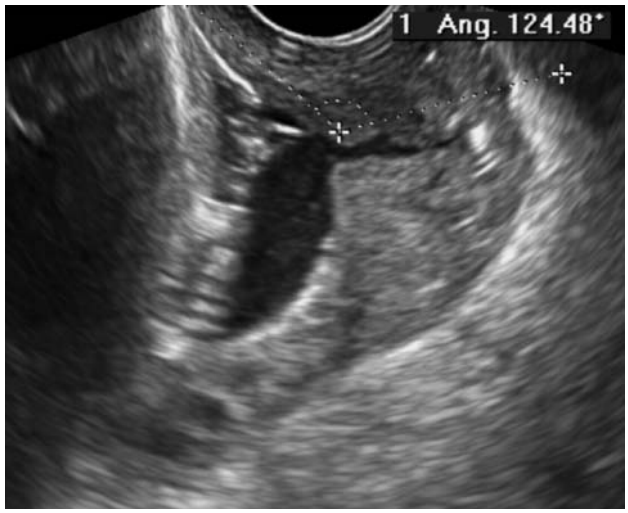

Fig. 2. In shape changes (Y- or U-like shape changes) corresponding to the early periods of funneling or the dilatation, cervical canal measurement between them is also considered as first straight line. The line drawn from the innermost point of cervical canal to anterior uterine segment was considered as the second straight line and the angle is measured.

Table 1. The distribution of the demographic characteristics of pregnant women in the groups according to their weeks of gestation (<37 and ≥37).

	Week of gestation during delivery		
	≥37 weeks (n=50) Mean±SD (Median)	<37 weeks (n=32) Mean±SD (Median)	p-value
Age (year)	26.93±6.40	25.88±4.67	ns[1]
Gravida (n)	2.04±1.29	3.03±1.62	**0.003***,[2]
Parity (n)	0.68±0.94	1.47±1.19	**0.001***,[2]
Abortion (n)	0.20±0.57	0.56±0.84	**0.023**†,[2]
NSD (n)	0.36±0.72	1.06±1.22	**0.002***,[2]
C/S (n)	0.26±0.63	0.38±0.66	ns[2]
BMI (kg/m^2)	27.35±3.77	27.12±4.70	ns[1]
Preterm labor history, n (%)	1 (2%)	2 (6.3%)	ns[3]
Smoking, n (%)	6 (12%)	5 (15.6%)	ns[3]
Cases with hypertension, n (%)	1 (2%)	2 (6.3%)	ns[3]
Cases with gestational diabetes, n (%)	1 (2%)	3 (9.4%)	ns[3]

[1]Student's t-test; [2]Mann-Whitney U test; [3]Chi-square test, Yates' correction for continuity and Fisher's exact chi-square tests; *p<0.01; †p<0.05.
ns: not significant; **C/S:** cesarean section; **BMI:** body mass index

No statistical difference was found in Bishop scores and the measurements carried out on cervical lengths, with threshold values which were considered 20 and 25 mm, respectively, of patients who underwent preterm labor. In our study, the sensitivity, selectivity, positive prediction value and negative prediction value of cervical lengths measured less than 20 mm were calculated 6.25%, 94%, 40% and 61%, respectively, for preterm labor. In this regard, there was no statistical difference between those who underwent preterm labor among the pregnant women who delivered at <37 and ≥37 weeks of gestation (**Table 3**).

The rate of uterocervical angle above 80.5° was calculated 75% in the preterm labor group (<37 weeks of gestation) while it was 42% in those who delivered at ≥37 weeks of gestation, which was high and statistically significant (p=0.007) (**Table 3**). The cut-off value (threshold value) was found 80.5° for uterocervical angle measurements depending on the preterm labor incidence. For this value, it was found that the sensitivity was 75%, selectivity was 58%, positive prediction value was 53.3% and negative prediction value was 77.3%. The area under the ROC curve obtained was 67%, and this area under curve was statistically significant (AUC=0.655, 95% CI=0.532–

Table 2. The data on women and newborns according to the weeks of gestation during delivery.

		Week of gestation during delivery		
		≥37 weeks (n=50) Mean±SD (Median)	<37 weeks (n=32) Mean±SD (Median)	p-value
Delivery week (week)		38.34±1.09	34.25±1.84	**0.001***,[1]
Newborn's birth weight (g)		3147.70±390.75	2496.47±654.67	**0.001***,[1]
Delivery type n (%)	NSD C/S	33 (66%) 17 (34%)	18 (56.3%) 14 (43.8%)	ns[2]
Newborn's intensive care unit need, n (%)		4 (8%)	10 (31.3%)	**0.015**†,[2]
Betamethasone dose, n (%)	N/A 1 2	40 (80%) 1 (2%) 9 (18%)	19 (59.4%) 2 (6.3%) 11 (34.4%)	ns[2]
Newborn's sex, n (%)	Female Male	23 (59%) 27 (62.8%)	16 (41%) 16 (37.2%)	ns[2]

[1]Student's t-test; [2]Chi-square test, Yates' correction for continuity and Fisher's exact chi-square tests; *p<0.01; †p<0.05.
ns: not significant; **C/S:** cesarean section; **NSD:** normal spontaneous delivery

0.777, p=0.019; p<0.05) (**Fig. 3**). This indicates that the probability of uterocervical angle being above 80.5° cut-off value in the measurements carried out in pregnant women who deliver before 37 weeks of gestation is statistically significant.

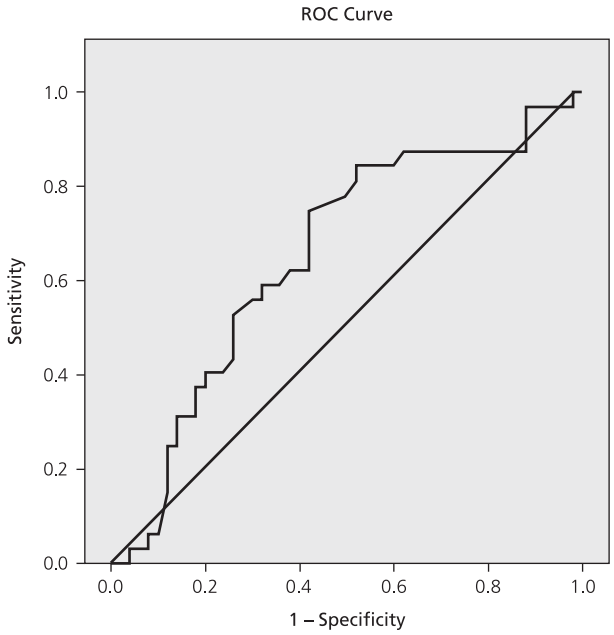

Fig. 3. ROC curve.

Discussion

Although there have been important developments in the prognosis of preterm newborns with the newborn intensive care techniques developed in the last two decades, no decrease has been achieved in the preterm labor rates.[3] There are studies showing that the risk of repeating preterm labor is increased in pregnancies with preterm labor history. In their study carried out to determine risk factors in preterm labors, Foix-L'Helias et al. reported the risk of preterm labor history (Odds Ratio: OR) as 4.5.[4] Similarly, El-Bastawissi et al. reported OR as 6 in the pregnant women with preterm labor history.[5] In our study, we found no difference between the groups in terms of obstetric history; 2% of pregnant women who delivered at ≥37 weeks of gestation and 6.3% of pregnant women who underwent preterm labor had preterm labor history; however, there was no statistically significant difference (p=0.557).

While there are many studies reporting that smoking increases preterm labor risk,[6–10] Anders and Day expressed in their studies that smoking is accounted for 15% of preterm labors.[11] In our study, only 11 (13.4%) out of 82 cases were smokers, and we found that smoking was not statistically significant between the groups (p=0.743).

There are studies reporting that maternal age is the most important factor among the socio-demographical factors in the preterm labor etiology, and that preterm labor rates prominently increase among the pregnancies before 20 years old.[12–14] Moreover, various risk scoring systems including the maternal age have been developed accordingly. The most known of these systems is Creasy risk scoring system, and mother is scored with 2 points if maternal age is under 20-year-old and above 40-year-old, and with 4 points if maternal age is under 18-year-old.[3,15] In our data, the mean age of term labor cases was 26.93 years and it was 25.88 for those who underwent

Table 3. Cervical lengths and uterocervical angles according to the delivery week.

		Week of gestation during delivery		
		≥37 weeks (n=50) n (%)	<37 weeks (n=32) n (%)	p-value[1]
Mean week of gestation during examination		31.21±3.07	30.57±3.34	ns
Bishop score		1.38±2.34	1.31±1.20	ns
Mean cervical length during examination (mm)		33.70±7.72	34.88±6.93	ns
Cervical length	<20 mm >20 mm	3 (6%) 47 (94%)	2 (6.3%) 30 (93.8%)	ns
Cervical length	<2 mm >25 mm	4 (8%) 46 (92%)	3 (9.4%) 29 (90.6%)	ns
Mean uterocervical angle during examination (°)		85.2±22.4	94.7±25.6	**0.001***
Uterocervical angle (°)	<80.5° >80.5°	29 (58%) 21 (42%)	8 (25%) 24 (75%)	**0.007***

[1]Mann-Whitney U test; *p<0.01. **ns:** not significant

preterm labor; however, we found no statistically significant difference (p=0.436).

In a study investigating the association between obesity and preterm labor, it was found in women with different body weights that preterm labor rate was 0.17% in those with BMI=18.5–25, 0.21% in those with BMI=25–30, 0.27% in those with BMI=30–35, and 0.52% in those with BMI >40, and it was highlighted that preterm labor rates increase as BMI increases.[16] On the other hand, Goldenberg et al. stated that low BMI significantly increases preterm labor risk in the preterm labor etiology.[17] Body mass indexes of pregnant women in our study vary between 18 and 40 kg/m^2, and the mean and median of BMI are 27.38±3.84 and 28 kg/m^2, respectively. In our study, the mean BMI was 27.12 in pregnant women who underwent preterm labor, and 27.35 in those who delivered at ≥37 weeks; we found statistically no significant difference between the groups (p=0.807).

Cervical length measurement is one of the leading methods used commonly to predict preterm birth. In the study of Tsoi et al. consisting of 216 singleton pregnancy cases associated with preterm birth, the authors reported that only one (0.6%) of 173 cases whose cervical lengths were 15 mm and higher underwent preterm labor, 16 (37.2%) of 43 pregnant women whose cervical lengths were less than 15 mm delivered within a week.[18] In the risk prediction study for preterm birth consisting of 730 cases, Tongsong et al. reported that the cut-off value of cervical length was 35 mm. The sensitivity of this cut-off value was 65.9±5.1% and selectivity was 62.4±5.2%. In this related study, cervical length was found <35 mm in 2/3 of the patients who underwent preterm labor.[19] The cervix lengths of the patients in our study vary between 10 and 48 mm, and the mean and median values were 34.16±7.08 and 36 mm, respectively. While the cervical lengths of 9.4% of pregnant women who delivered before 37 weeks of gestation were less than 25 mm, only 6.3% of them had cervical lengths less than 20 mm. The sensitivity, selectivity, positive prediction value and negative prediction value of cervical lengths less than 20 mm were calculated 6.25%, 94%, 40% and 61%, respectively, for preterm labor. In consideration of the data of our study, we concluded that cervical length is not a sufficient method to predict preterm birth. Similarly, Bishop scores which are a subjective examination finding varied between 0 and 8, and it was found 1.38±2.34 and 1.31±1.20 in the control and study groups, respectively, which were not significant in terms preterm birth (p=0.195).

On the other hand, we observed differences in the weeks of gestation and cervical angles among the groups in association with gravida, parity, abortion and vaginal delivery histories in our study. While there is no difference between the study and control groups in terms of cervix lengths, different cervical angles are remarkable and questionable. It is clear that there will be changes in the cervix structure of multiparous women together with previous deliveries; we refer it "multiparous dilatation" in the gynecological examinations. In this regards, uterocervical angle can be considered as a sonographic reflection of uterocervical sub-segment maturation in particular, although the change continues during the pregnancy. Cervical length in multiparous patients and these changes in the uterocervical angle are also expressed in the literature.[20,21]

Uterocervical angle measurement was first investigated by Dziadosz et al. as a tool in the prediction of preterm birth.[22] They performed cervical imaging by transvaginal ultrasound in 972 singleton pregnant women who admitted between 16 and 24 weeks of gestation. It was found that the cases with UCA >95° underwent significantly more preterm labors before 37 weeks of gestation (sensitivity 80%; p<0.001; negative prediction value 95%), and the cases with UCA>105° underwent more deliveries before 34 weeks of gestation (sensitivity 81%; p<0.001; negative prediction value 99%). A secondary result obtained in the same study was that cervical length (<25 mm) is significant for the prediction of preterm birth. However, since sensitivity is 62% and negative prediction value is 95% in preterm births before 37 weeks of gestation and sensitivity is 63% and negative prediction value is 97% in preterm births before 34 weeks of gestation, it has been concluded that UCA measurement is more successful than cervical length measurement for the prediction of preterm birth. These data are also supported by similar studies.[21,23,24]

In our study, UCA measurements varied between 50 and 150° in 82 patients who admitted to the emergency maternity clinic between 24 and 34 weeks of gestation, the mean value was 88.91° and we calculated threshold value 80.5° for uterocervical angle measurements depending on the preterm birth (<37 weeks) incidence. For this value, the sensitivity was 75%, selectivity was 58%, positive prediction value was 53.3% and negative prediction value was 77.3%. The area under the ROC curve obtained was 67%, and this area under curve was statistically significant (AUC=0.655, 95% CI=0.532–

0.777, p=0.019; p<0.05). The rate (75%) of uterocervical angle being more than 80.5° in women whose weeks of gestation are below 37 during delivery higher than the rate of those whose weeks of gestation are 37 and above, and it is statistically significant (p<0.01). These data are also similar to the results of the study of Dziadosz et al. UCA measurement in the prediction of preterm birth is an important method with higher sensitivity, higher positive prediction value and lower negative prediction value than cervical length measurement.

Conclusion

Today, preterm birth continues to be the most serious reason for newborn mortality and morbidity. With its results, our study, which we prepared to understand etiological factors, develop early diagnostic methods and tools, and to contribute raising healthier individuals by taking diagnostic precautions, has shown that uterocervical angle measurement is an important method for the prediction of preterm birth. It is important and necessary to do further investigations on this matter in terms of developing diagnosis and treatment methods and achieving positive results.

Conflicts of Interest: No conflicts declared.

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