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Correlation of Cervical Length, Anterior Uterocervical Angle, and Cervical Elastography with the Incidence of Preterm Labor

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Abstract

Objectives The aim of this study is to find the correlation of cervical length, anterior uterocervical angle, and cervical elastography with the incidence of preterm labor through evaluation by transvaginal ultrasonography during routine anomaly scan and to analyze the correlation of the parameters with each other.

Methods Cross-sectional comparative study was undertaken on singleton pregnant women coming for anomaly scan between 18 and 24 weeks. Cervical length and anterior uterocervical angle were measured in the mid-sagittal section. Strain elastography was used for measuring cervical strain. Color map was obtained for the entire cervix and the color code for the degree of cervical stiffness was noted.

Results Though the mean value of cervical length was significantly lower in preterm group (3.2 cm) than in term group (3.6 cm), it was more than the cutoff value of 2.5 cm, below which it is routinely considered as short cervix indicative of preterm labor. Mean value of anterior uterocervical angle was significantly higher in women with preterm (112.3 degrees) delivery than those with term (82.2 degrees) delivery. Mean strain values of cervical elastography were significantly different in term (0.130) and preterm groups (0.179). Color code in elastography was independent of preterm labor. There was a significant positive correlation of cervical length with gestational age at delivery (GAD). A significant negative correlation was observed between acute anterior uterocervical angle with the GAD.

Conclusion Anterior uterocervical angle has a definitive role in the prediction of preterm labor and so it can be combined with the conventional cervical length screening in identifying women with normal cervical length who are at high risk of preterm labor. Cervical elastography assesses the cervical consistency and also has the potential for identifying high-risk women.

Keywords
- cervical length
- anterior uterocervical angle
- cervical elastography
- preterm labor

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Introduction

Preterm delivery (PTD) is defined as delivery occurring less than 37 completed weeks of gestational age. It is one of the important causes of neonatal morbidity and mortality worldwide and is responsible for long-term morbidity in children. In India, 3.5 million babies are born preterm out of 27 million births every year (2010 data).[1,2]

Premature neonates who survive are more prone to develop serious complications such as cardiovascular and respiratory dysfunction and motor and intellectual deficiencies. High-risk factors include maternal characteristics like previous history of abortions and previous preterm labor (PTB); however, they are ineffective in predicting PTB in the present pregnancy. Current screening tools for the prediction of PTB, applied in first and second trimesters, detect 55 and 69% of spontaneous preterm births, respectively.[1] Thus, spontaneous PTB remains one of the least predictable complications of pregnancy. Maternal characteristics and cervical pathologies are generally attributed to PTD. Some of these issues are addressed with the help of ultrasonography.

Conventionally cervical length measured by transvaginal ultrasound is used to identify women at risk of PTD. The risk of preterm birth varies inversely with cervical length measured by transvaginal/transabdominal scan at 20 to 22 weeks. A cutoff of 2.5 cm predicted PTD less than 35 weeks with a sensitivity of 37.3%, while two-thirds of the cases remained undetected. Hence, there is a subset of high-risk group within the asymptomatic patients with a normal cervical length.[3] This warranties the search for additional diagnostic tests in patients with normal cervix length.

Recently, a novel ultrasound parameter, the anterior uterocervical angle (UCA) has been used as a predictor of spontaneous preterm birth and promising results have been acquired in certain trials. It is the angle measured between the anterior uterine segment and the cervical canal in an anteverted uterus. This angle increases with advancing gestational age. Studies have shown that there is a significant difference in mean angle between women who delivered preterm and that of those who delivered at term in both first trimester and second trimester.[1]

When cervical ripening happens too fast, it leads to cervical incompetence. In spite of the lack of uterine contractions and low tone of the uterus, cervix begins to shorten and then dilate causing the expulsion of the fetus. Thus, it is crucial to do an ultrasonographic cervical assessment at 18 to 22 weeks of gestation.

Elastography is a newer application of ultrasound that assesses the mechanical and tensile properties of soft tissue. In addition to providing objective information about cervical consistency, it is also suitable for the evaluation of the internal os (ostium), which cannot be assessed by per vaginal examination as in the case of bishop score evaluation.

Maternal characteristics like previous history of abortions and previous PTB pose as risk factors responsible for early delivery. More importantly, cervical length, anterior UCA, and cervical strain seem to play an important role in predicting PTD.

Aim and Objectives

- To determine the correlation of cervical length, anterior UCA, and cervical elastography with the incidence of PTB in the pregnant women who come for routine anomaly scan from 18 to 24 weeks.
- To analyze the correlation of these parameters with each other.

Materials and Methods

A cross-sectional comparative study was undertaken in the Department of Fetal Medicine, Kovai Medical Centre and Hospitals, Coimbatore.

Study subjects: Pregnant women coming for routine anomaly scan in antenatal ultrasonography.

1. Pregnant women diagnosed with cervical incompetence in the present pregnancy and those for whom cervical cerclage has been done.
2. Pregnant women with retroverted uterus were excluded from the study.

Maternal characteristics data of 124 pregnant women were captured using the questionnaire. Data acquisition was done in consensus by three well-trained doctors in fetal medicine using real-time transvaginal ultrasonography by using Voluson E10 system with 5 to 9 MHz transvaginal probe aligning the transducer perpendicular to the long axis of cervix. Cervical length was measured from the internal os to the external os in the mid-sagittal section. Anterior UCA was measured in the mid-sagittal section by drawing two lines—the first straight line is drawn through endocervical canal between internal os and external os, and the second line is drawn ideally 3 cm from the internal os through the anterior uterine segment. Strain elastography was performed by exerting one to two cycles of the gentle compression-relaxation phases along the longitudinal axis of the cervix. Sample box was placed covering the entire cervix. Ideal compression by the operator was assessed by the compression box on the right side of screen, which on optimal pressure becomes fully green. Two regions of interest (ROI) of size 5 mm were placed anterior and posterior to cervical canal at the level of internal os and the corresponding strain values were taken as ROI 1 and ROI 2, respectively. Mean strain value was calculated and taken for analysis. Color map was obtained for the entire cervix and the color code for the degree of cervical stiffness was noted as follows: red—very soft, yellow—soft, orange—medium soft, green—firm, blue—hard, and violet—very hard. Sample volume was placed covering the entire cervix, and on selecting the elasto preset, color code was seen overlapping the B mode of cervix. The more homogeneous color at ROI os was taken as the color code for the given patient. If two colors overlapped, then the softer color was chosen. The procedure was repeated two to three times to get a consistent result.

Statistical analysis was performed using the SPSS software 23. Independent sample *t*-test was used to compare the association between cervical length, uterocervical cervical

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angle, and cervical elastography (strain value) and preterm birth. Pearson's product moment correlation was used to analyze the relationship between cervical length and gestational age at delivery (GAD), anterior UCA and GAD, and cervical elastography and GAD.

Results

The study population consisted of 124 pregnant women, out of whom 18 (14.5%) delivered preterm and the remaining 106 (85.5%) women delivered at term. The percentage (14.5%) of women with PTD is higher than that of global and all India estimates of 10.6 and 13.6%, respectively.

Seventy-five percent of patients with a history of second-trimester abortions/cervical incompetence in their previous pregnancies delivered preterm, while 25% of them went in for term delivery. Only one woman in the study population had a history of PTB in the past, and she delivered at term.

Mean value of cervical length in the preterm group (3.2 cm) was lower than that of the term group (3.6 cm) with a statistically significant difference ($t = 3.762$, $p < 0.0001$). Mean value of UCA was higher in the preterm group (112.3 degrees) than in the term group (82.2 degrees) and the difference was found to be statistically significant ($t = -8.139$, $p < 0.0001$). Mean strain value of ROI 1 was higher (0.166) in the preterm group than in the term group (0.128) with the statistically significant difference ($t = -2.030$, $p = 0.045$). Mean strain value of ROI 2 was higher in preterm (0.191) than in the term group (0.132); however, the difference was not significant ($t = -2.000$, $p = 0.060$). Mean strain value (determined from the two ROIs) was higher in preterm (0.179) than in the term group (0.130) with significant difference ($t = -2.169$, $p = 0.043$; ►**Fig. 1**, ►**Table 1**).

More than one-third of the participants (37.9%) falling under blue code had hard cervix. Around one-third of them (29%) came under green code representing firm cervix. The remaining 11.3 and 3.3% of the participants showed yellow and orange color codes, respectively, representing soft cervix. Though chi-squared value was not statistically significant, the prevalence of hard cervix was found to be higher in term pregnancy (59.4%). The prevalence of firm cervix was higher in preterm (44.4%) and the prevalence of soft cervix was 14.2 in term and 16.7% in preterm (►**Fig. 2**).

The correlation between cervical length of women and the GAD was calculated. There was a positive and significant correlation between them ($r = 0.234$). There was a significant negative correlation between anterior UCA and GAD ($r = -0.355$). There was a negative correlation between the mean

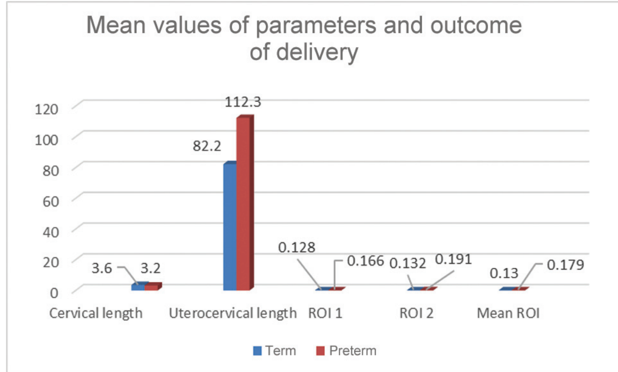

Fig. 1 Bar graph showing the mean values of the parameters (cervical length, uterocervical angle, and strain values of elastography) with respect to the outcome of delivery (term/preterm). ROI, region of interest.

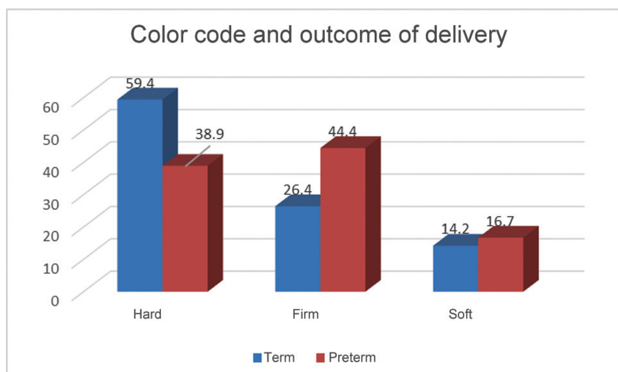

Fig. 2 Bar graph showing the comparison of color code with outcome of delivery.

Table 1 Comparison of mean values and different parameters with respect to outcome of delivery

Variable	Group	Mean	SD	Mean difference	*t*-Value	*p*-Value
Cervical length	Term	3.6	0.42	0.40	3.762	<.0001
	Preterm	3.2	0.43			
Anterior uterocervical angle	Term	82.2	14.3	30.07	−8.139	<.0001
	Preterm	112.3	15.2			
ROI 1 (strain value)	Term	0.128	0.071	0.037	−2.030	0.045
	Preterm	0.166	0.085			
ROI 2 (strain value)	Term	0.132	0.0274	0.059	−2.000	0.060
	Preterm	0.191	0.122			
Mean strain value	Term	0.130	0.058	0.048	−2.169	0.043
	Preterm	0.179	0.091			

Abbreviations: ROI, region of interest; SD, standard deviation.

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Table 2 Intercorrelation among the parameters

	Pearson correlation	*p*-Value
Cervical length and cervical elastography	−0.124	0.169
Anterior uterocervical angle and cervical elastography	0.206	0.022
Anterior uterocervical angle and cervical length	−0.186	0.038

strain value and GAD, though it was not statistically significant ($r = -0.161$).

There was a negative correlation observed between cervical length and strain value of elastography without statistical significance ($r = -0.124$, $p = 0.169$). It was found that there was a significant positive correlation between anterior UCA and elastography ($r = 0.206$, $p = 0.022$) and a significant negative correlation between cervical length and anterior UCA ($r = -0.186$, $p = 0.038$; ►**Table 2**). Example cases are shown in ►**Figs. 3–6**.

Discussion

Though PTB remains a common cause of perinatal and neonatal morbidity, detection by ultrasound in the present setting carries less sensitivity and specificity.

The standard cutoff of cervical length assessed by transvaginal ultrasound for the risk of PTB as per the literature is 2.5 cm. It was found that the mean values of the cervical length between preterm (3.2 cm) and term groups (3.6 cm) were significantly different in this study. A significant positive correlation was demonstrated between the cervical length and GAD. These findings are consistent with previous studies.[4–7] However, some studies reported contrary findings, suggesting that there is weak or no correlation between cervical length and PTD.[8]

Anterior UCA has been proposed as a new biophysical marker, recently being explored as a tool for the prediction of PTB. UCA of the women delivering at preterm was wider than those of women with term births in this study. Similar significant difference was reported by Sochacki-Wójcicka et al in preterm and control (term) group study.[9] Of note, in our study, there was a significant negative correlation between anterior UCA and GAD. So, when UCA increases and becomes more obtuse, there is a decrease in the gestational age at birth indicating an increased risk for PTB.

Margaret Dziadosz et al found that a wide UCA more than 95 and more than 105 degrees detected during the second trimester was significantly associated with an increased risk for spontaneous preterm birth less than 37 and less than 34 weeks, respectively.[10] Sepúlveda-Martínez et al also confirmed that pregnant women with a wide UCA were prone to deliver preterm (<34 weeks) compared with

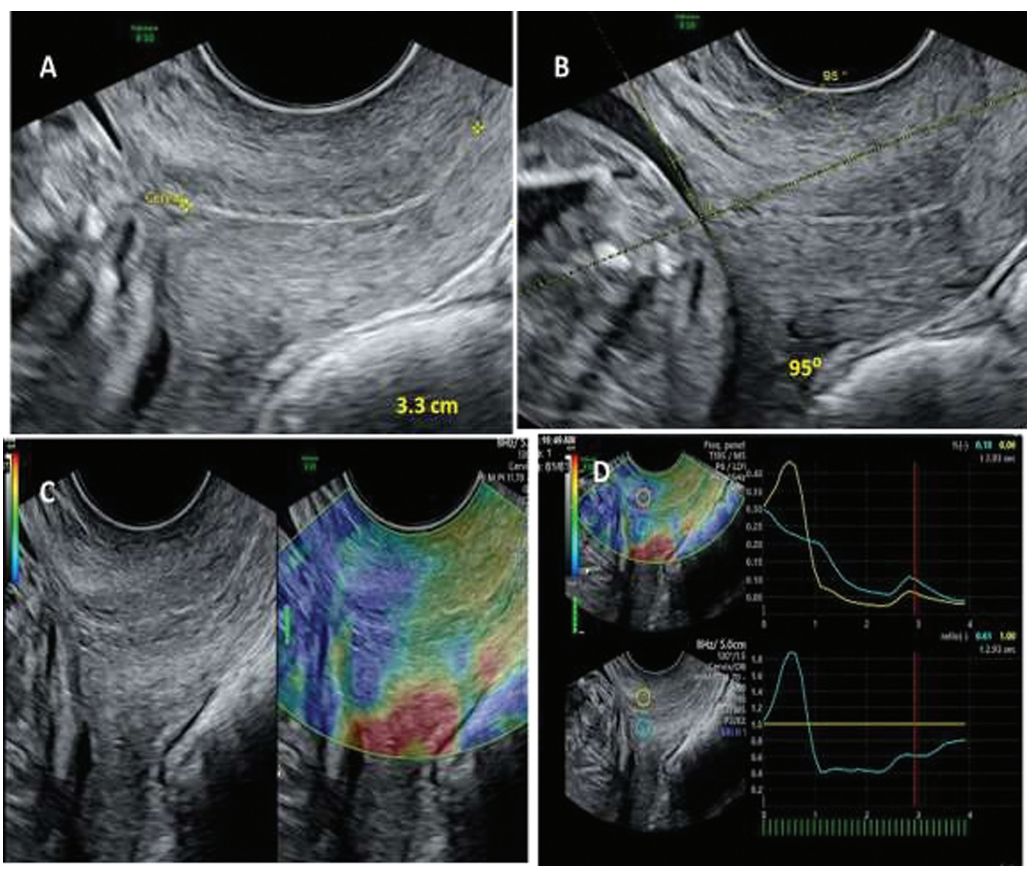

Fig. 3 Patient 1—Transvaginal ultrasound was done. (**A**) Cervical length measured 3.3 cm. (**B**) Anterior uterocervical angle between the cervical canal and anterior lower uterine segment was found to be 95°C. (**C**) On elastography color code at the level of internal os was violet. (**D**) Strain values anterior and posterior to the cervical canal at the same level were 0.06 and 0.10, respectively. She delivered at term (38 weeks, 2 days).

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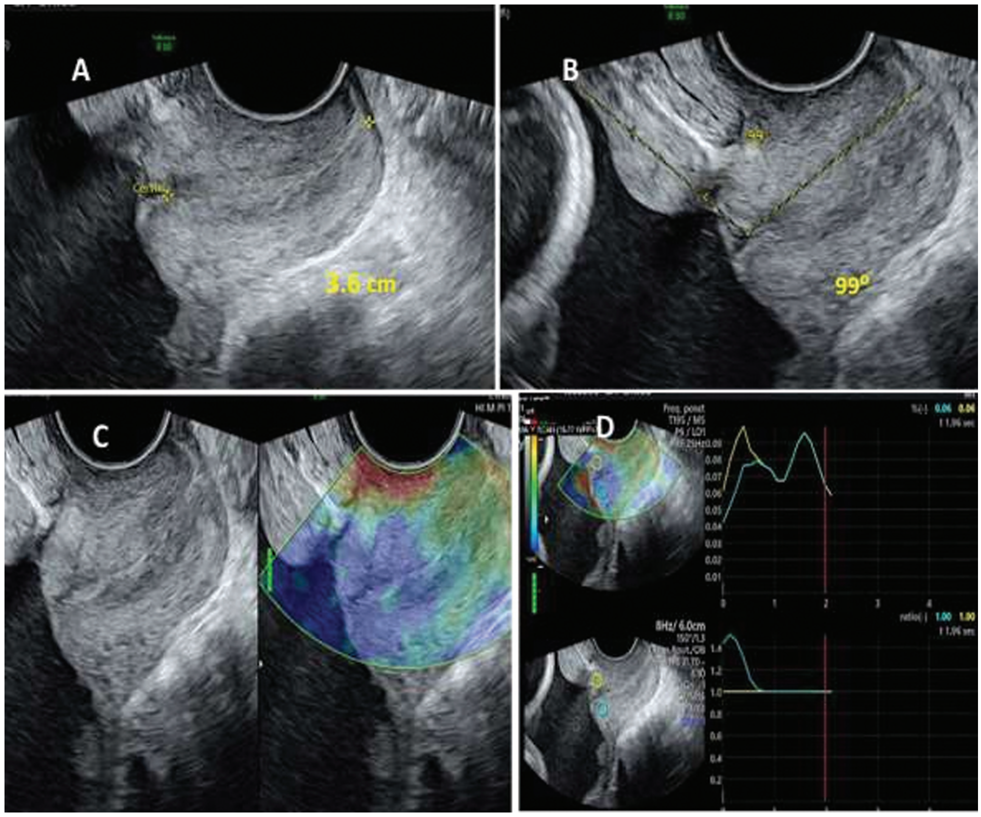

Fig. 4 Patient 2—Transvaginal ultrasound was done. (**A**) Cervical length measured 3.5 cm. (**B**) Anterior uterocervical angle between the cervical canal and anterior lower uterine segment was found to be 99 degrees. (**C**) On elastography color code at the level of internal os was violet. (**D**) Strain values anterior and posterior to the cervical canal at the same level were 0.06 and 0.06, respectively. She delivered at term (39 weeks, 2 days).

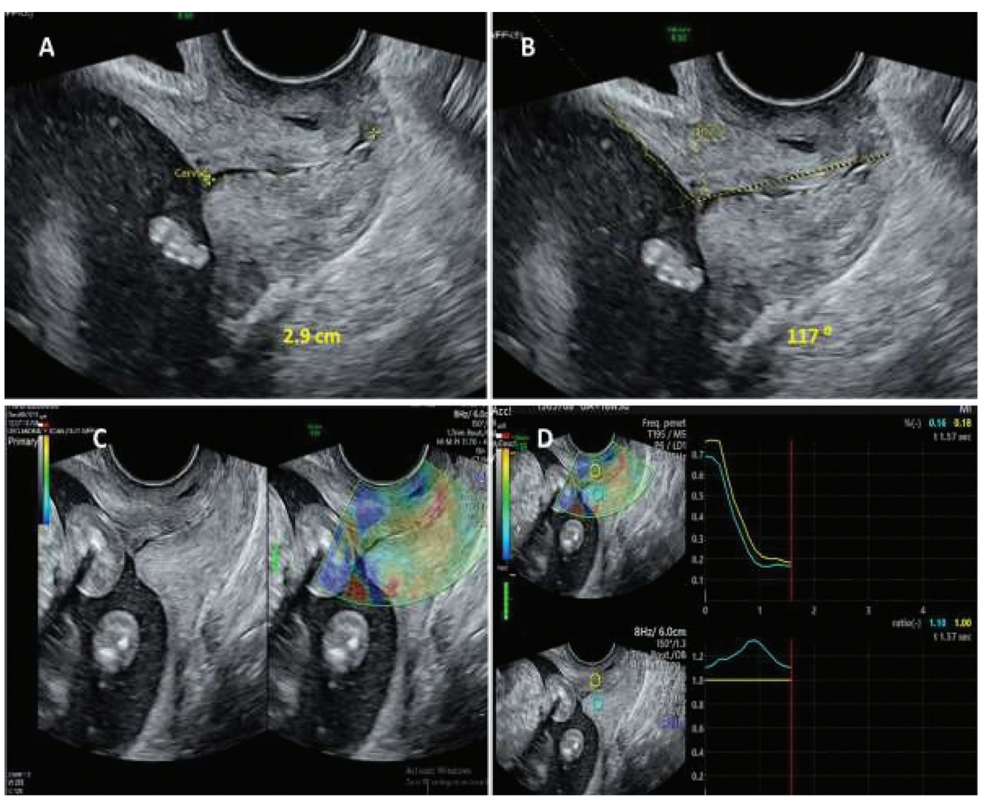

Fig. 5 Patient 3—Transvaginal ultrasound was done. (**A**) Cervical length measured 2.9 cm. (**B**) Anterior uterocervical angle between the cervical canal and anterior lower uterine segment was found to be 117 degrees. (**C**) On elastography color code at the level of internal os was green. (**D**) Strain values anterior and posterior to the cervical canal at the same level were 0.18 and 0.16, respectively. She delivered preterm (34 weeks, 7 days).

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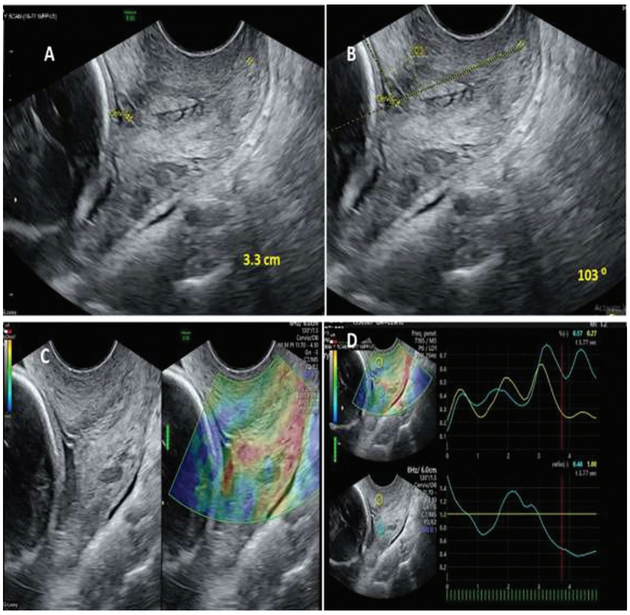

Fig. 6 Patient 4—Transvaginal ultrasound was done. (**A**) Cervical length measured 3.3cm. (**B**) Anterior uterocervical angle between the cervical canal and anterior lower uterine segment was found to be 103 degrees. (**C**) On elastography color code at the level of internal os was orange. (**D**) Strain values anterior and posterior to the cervical canal at the same level were 0.18 and 0.16, respectively. She delivered preterm (30 weeks, 7 days).

women that delivered at term.[11] Similar finding was also reported by Farràs Llobet et al.[12] In line with this observation, Lynch et al concluded that although a change in UCA did not seem to predict PTB, absolute UCA measurements seem to have predictive value.[13] Consistently Bafali inferred that UCA greater than 80.5 degrees was associated with high risk of preterm births less than 37 weeks of gestation.[14]

Cervical elastography assesses the biochemical changes in the cervix during pregnancy and gives an estimation of the cervical consistency, which cannot be determined by the other ultrasound parameters. In this study, strain values were measured in two ROI—in the anterior and posterior cervical canal at the level of internal os. The mean strain value was then calculated. Statistically significant difference was evident between the term and preterm birth groups.

The study showed an association between the stiffness of the cervix measured in terms of hardness represented by color codes (violet, blue, green, orange, yellow) and the outcome of delivery, that is, term and preterm, though it was not statistically significant. However, the prevalence of hard cervix was higher in term group and the prevalence of firm and soft cervix in the preterm group. Previous studies have also reported the association between soft cervix and PTD but with statistical significance.[3,15–17] However, another study by Mishrikotkar et al did not find significant association between elastography (soft cervix determined by color code) and PTD.[18]

Furthermore, this study tried to determine the relationship between the mean strain value and gestational age at birth and found that there was only a provisionally significant negative correlation between them. Though the relationship between the two variables in question may not be statistically significant as defined by 0.05 level of confidence, there still seems to be a relationship between cervical elastography and GAD.

This finding is consistent with previous statistically significant results.[18–22] Conversely, a study by Park et al demonstrated that there was no difference in cervical length and elastography parameters between pregnancies with and without spontaneous PTD.[21] However, the result turned out to be significant in a subgroup of women with moderately short cervix (1.5–2.5 cm). In the light of the above discussion, it can be concluded that cervical elastography may play an important role in assessing the risk of PTB.

On analyzing the intercorrelations among the three parameters, it was seen that significant positive correlation existed between anterior UCA and strain values of elastography implying that women with wider anterior UCA were likely to have softer cervix. In the case of relationship between cervical length and anterior UCA, a significant negative correlation was observed. So, women with shorter cervix were prone to have a wider anterior UCA in accordance with previous studies.[9,11,23,24]

So, it may be concluded from the present research that there is a significant relationship between the cervical length and UCA and between UCA and mean strain value (elastography), whereas the relationship between cervical length and mean strain value is not significant.

Conclusion

In consideration of the preterm morbidity and mortality, ultrasound parameters in addition to the maternal characteristics are essential to increase the detection of preterm births. In this study, it has been found that anterior UCA has a definitive role in the prediction of PTB and so it can be combined with the conventional cervical length screening in identifying women with normal cervical length who are at high risk of PTB. Cervical elastography assesses the cervical consistency and also has the potential for identifying the high-risk women. However, larger trials with larger sample size are needed to validate this parameter and standardize the technique before it is incorporated into clinical practice.

Recommendations

- Routine cervical screening with transvaginal ultrasound in second trimester should be made mandatory.
- Anterior UCA can be considered as complementary to cervical length to increase the detection rate of preterm birth.
- Cervical elastography is a promising tool for the prediction of PTD by assessing the cervical consistency; however, larger trials with multicenter study are needed to evaluate and ascertain the correlation of the parameter with PTB and also for the standardization of the technique across centers and also in different ultrasound machines.

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Authors' Contributions

All authors contributed to the study conception and design. Sumathi Natarajan, Saira Rajan, and Amudhavalli Subramani helped in material preparation, data collection, and analysis. Ezhilmathi Alavandar, Ravindar Kashyap, and Dhivakar Muthusamy wrote the first draft of the manuscript, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Ethical Approval

Approval was obtained from the ethics committee of Kovai Medical Centre and Hospitals. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to Participate

Informed consent was obtained from all individual participants included in the study.

Consent for Publication

Patients signed informed consent regarding publishing their data and photographs.

Conflict of Interest

None declared.

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