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Study Of Evaluation Of Combined Cervical Length And Cervical Elastography As Predictors Of Spontaneous Preterm Birth.

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ABSTRACT

Preterm birth (PTB) is a significant cause of neonatal morbidity and mortality. Accurate prediction of spontaneous preterm birth (sPTB) is essential for timely intervention. While cervical length (CL) is a well-established predictor, combining it with cervical elastography (stiffness) may enhance predictive accuracy. This prospective observational study included 180 pregnant women between 18–24 weeks of gestation at a tertiary care hospital. Transvaginal 2-D ultrasonography was used to measure cervical length, and shear wave elastography assessed cervical stiffness. Data were analyzed using chi-square tests, and sensitivity, specificity, PPV, and NPV were calculated. Among 180 women, 5 had combined short (<25 mm) and soft (≤25th percentile stiffness) cervices, of which 4 (80%) experienced sPTB <37 weeks ($p = 0.00008$). Combined short and soft cervix showed 100% sensitivity and 98.5% specificity for sPTB <34 weeks, outperforming either parameter alone. Normal cervical length and stiffness were associated with the lowest sPTB risk (0.82%).Combining cervical length and stiffness significantly improves prediction of sPTB, enabling better risk stratification and targeted management.

Keywords: Preterm birth, cervical length, cervical elastography

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INTRODUCTION

Preterm birth, defined as delivery before 37 weeks of gestation, is a significant global health issue associated with high neonatal morbidity and mortality [1]. It contributes to long-term complications such as developmental delays, chronic respiratory conditions, and neurological deficits. Early identification of women at risk of spontaneous preterm birth (sPTB) is crucial for implementing timely interventions to improve maternal and neonatal outcomes [2, 3].

Cervical length (CL) measurement using transvaginal ultrasound has been a widely studied and accepted method for predicting sPTB. Shortened cervical length is a reliable indicator of increased risk, particularly in asymptomatic women and those with a history of preterm delivery. However, cervical length alone may not fully capture the biomechanical properties of the cervix, such as stiffness and elasticity, which are critical in the process of cervical remodelling during pregnancy [4, 5].

Cervical elastography, a non-invasive imaging technique that assesses cervical stiffness, has emerged as a complementary tool to cervical length measurement. Combining cervical length with cervical elastography may enhance the predictive accuracy for sPTB by providing a more comprehensive assessment of cervical integrity [6]. Our study aims to evaluate the effectiveness of combined cervical length and cervical elastography in predicting spontaneous preterm birth, contributing to better screening and management strategies for high-risk pregnancies.

STUDY METHODOLOGY

This prospective observational cohort study was conducted on 180 women with singleton pregnancies between 18 to 24 weeks of gestation. Participants were those presenting for routine second-trimester ultrasound (USG) for fetal anomaly screening at the Department of Radiodiagnosis, HIMSR, New Delhi. Ethical approval was obtained from the PG Board of Ethics Committee at Hamdard Institute of Medical Sciences & Research, New Delhi, prior to the commencement of the study. Written informed consent was obtained from all participants for performing transvaginal 2D ultrasonography and elastography.

The study was conducted over 18 months, from November 2023 to April 2024. The sample size was calculated using standard formulae with a level of significance set at 5%, a prevalence rate of 11%, and a margin of error of 5%, resulting in a required sample size of 158 participants. To ensure sufficient data, 180 participants were recruited. Inclusion criteria included singleton pregnancies in both primigravida and multigravida women between 18 to 24 weeks, with no prior cervical surgeries, cervical cerclage in situ, or evidence of cervical dilation, funneling, or rupture of membranes.

Participants with multiple pregnancies, prior cervical surgeries, a BMI greater than 30, asthma, COPD, placenta previa, placenta accreta, or cervical abnormalities such as funneling or premature rupture of membranes were excluded. These exclusion criteria ensured a homogenous sample to evaluate cervical length and elasticity under controlled conditions.

The Samsung Prestige RS-85 machine, equipped with a single intravaginal probe, was used for both 2D grayscale cervical length assessment and shear wave elastography with color code mapping. This integrated system eliminated the need to switch between machines and probes, thereby optimizing time and improving accuracy. Data collected from cervical evaluations were analyzed to assess their predictive value for spontaneous preterm birth.

RESULTS

Table 1: Shows number of pregnant women with combined short and soft cervix and incidence of sPTD < 37 weeks of gestation.

No of pregnant women with combined short and soft cervix (out of. 170)	No. of sPTD <37 weeks	% of sPTD
5	4	80 %

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Table 1 shows the number of cases having combined short cervix < 25 mm and soft cervix (less than 25 percentile of stiffness i.e. warm colors was 5, out of which 4 (80 %) had preterm delivery < 37 weeks in this study, with p-value of 0.00008 . This clearly shows that combined short and soft cervix is a better predictor for PTD as compared to short alone or soft alone cervix.

Table 2: Cervical Parameters with respect to incidence of sPTB between 34- 37 weeks and less than 34 weeks.

Cervical Parameter	No. of Cases & %	Total No. & % of SPTD	sPTB 34 – 37 wk No. & % of Cases	sPTB < 34 wk No & % of Cases	p-value (Chi-square Test)
Short cervix alone (< = 25 mm)	12 (7%)	3 (25%)	1	2	0.000021
Soft cervix (Warm colors – red and yellow)	14 (8.2%)	9 (65%)	4	5	0.00014
Short and soft cervix (< = 25 mm and warm colors)	5 (2.9%)	4 (80%)	1	3	0.00008
Normal cervical length and stiffness	122 (71.7%)	1 (0.82 %)	0	1	----

Table 2 shows, that in this study, 12 (7%) of cases had a short cervix alone (≤ 24 mm), out of which w 3 (25%) resulted in sPTB, 1 between 34-37 weeks and 2 cases before 34 weeks.

Table 3: Cervical Parameters Analysis showing sensitivity, specificity, PPV, NPV, LR + and LR- of short cervix, soft cervix and combination of the two.

Cervical Parameter	Sensitivity	Specificity	PPV	NPV	Likelihood Ratio + 95% CI	Likelihood Ratio - 95% CI
Short cervix (<=25 mm)						
sPTB < 34 weeks	67%	98.5%	33.3%	99.1%	45.33	0.34
sPTB < 37 weeks	15%	98.5%	25%	92.9%	10.0	0.86
Short & soft cervix (<=25 mm and soft)						
sPTB < 34 weeks	100%	98.5%	60%	100%	66.67	0.0
sPTB < 37 weeks	15%	98.5%	80%	92.6%	10.0	0.86
Soft alone						
sPTB < 34 weeks	33.3%	91.1%	35.7%	90.2%	3.75	0.73
sPTB < 37 weeks	33.3%	91.1%	64.3%	75.8%	3.75	0.73

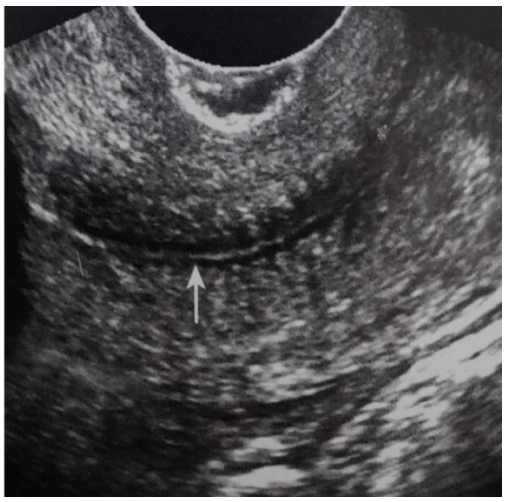

Figure 1: Uterine Cervical Canal appear as echogenic line, extending between internal and external os, Isurrounded by hypoechoic glandular area In sagittal section on 2-D Ultrasonography.

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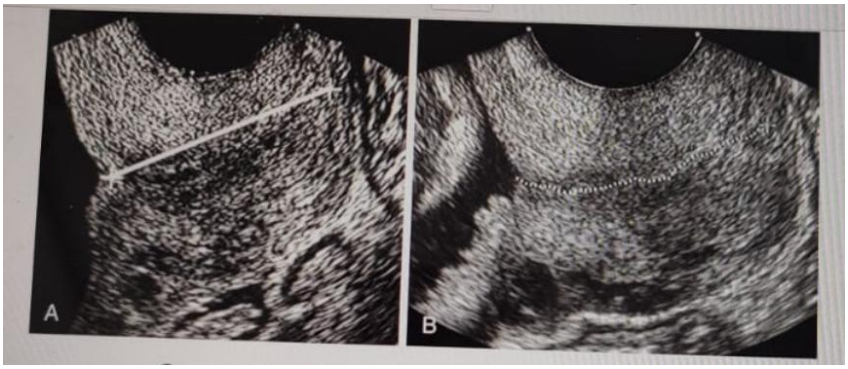

Figure 2: Uterine cervical canal length in a highly curved cervical canal (more than 5 mm from the straight line joining the internal and external OS is calculated by sum of two straight line distances, one along the upper segment from internal OS to the intersection of the two lines and the distance between the external OS and the intersection.

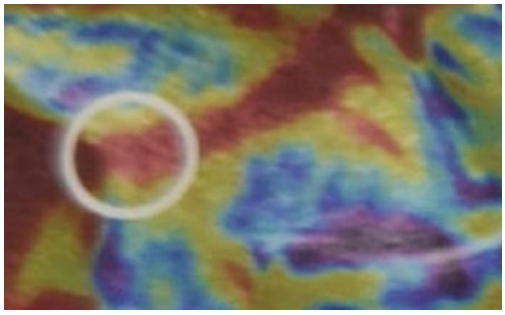

Figure 3: SWS Elastographic Red Color Mapping showing Soft Internal OS.

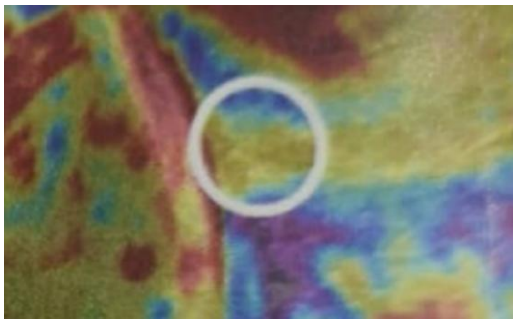

Figure 4: Elastographic SWS Color Mapping showing Yellow Color indicating Medium Soft Internal OS. Both red and yellow Color Mapping (warm colors) show less than 25 percentiles of SWS Elastography.

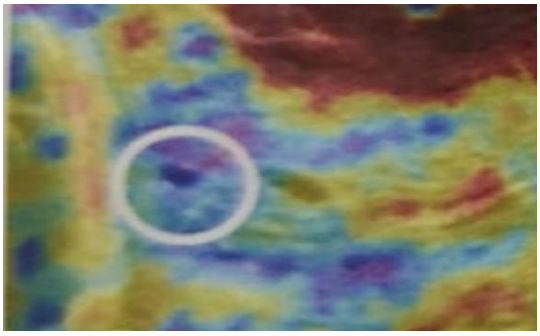

Figure 5: SWS Elastographic Color Mapping image showing blue color indicating medium hard uterine cervix at internal OS.

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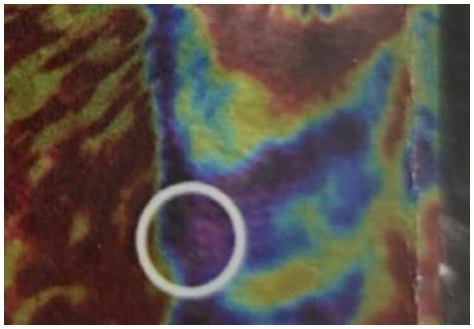

Figure 6: SWS Elastographic Color Mapping image showing purple color indicating hard uterine cervix at internal OS. Blue as well as purple (Cold Colors) are above 25 percentiles of SWS.

DISCUSSION

Preterm birth (PTB) remains a leading cause of neonatal morbidity and mortality worldwide, underscoring the need for effective predictive tools to identify at-risk pregnancies [7]. In this study, the combined assessment of cervical length (CL) and cervical stiffness using transvaginal 2-D ultrasonography and shear wave elastography was evaluated for its ability to predict spontaneous preterm birth (sPTB). The findings demonstrate that a combined short and soft cervix is a superior predictor of sPTB compared to assessing cervical length or stiffness alone [8, 9].

Demographic Characteristics and Study Population

Out of 180 pregnant women initially enrolled, 10 were lost to follow-up, leaving 170 participants for analysis. The majority (53%) of participants were aged 26–30 years, with a minimum age of 22 years and a maximum of 37 years. These findings align with prior studies that identify maternal age as a potential contributor to pregnancy outcomes, although age alone is not a direct predictor of PTB.

Combined Short and Soft Cervix as a Predictor of sPTB

Table 1 highlights the significance of a combined short and soft cervix in predicting sPTB. Among 5 cases with a combined short (<25 mm) and soft cervix (cervical stiffness in the lowest 25th percentile, depicted by warm colors), 4 (80%) resulted in sPTB before 37 weeks, with a highly significant p-value of 0.00008. This emphasizes that integrating cervical length and stiffness provides a more comprehensive assessment of cervical remodeling, which is critical in the pathophysiology of PTB.

Analysis of Cervical Parameters and sPTB Incidence

The cervical parameters were further analyzed for their association with sPTB, as presented in Table 2. Among 12 cases with a short cervix alone, 3 (25%) resulted in sPTB, with one occurring between 34–37 weeks and two before 34 weeks ($p = 0.000021$). Conversely, among 14 cases with a soft cervix alone, 9 (65%) experienced sPTB, with 4 between 34–37 weeks and 5 before 34 weeks ($p = 0.00014$). Notably, all cases with a combined short and soft cervix had a higher incidence of sPTB (80%) compared to either parameter alone. This finding underscores the synergistic effect of combining these two markers in predicting adverse pregnancy outcomes.

Sensitivity, Specificity, and Predictive Values

The diagnostic performance of cervical parameters was analyzed in Table 3. For predicting sPTB before 34 weeks, a short cervix alone had a sensitivity of 67% and specificity of 98.5%, while a soft cervix alone had a sensitivity of 33.3% and specificity of 91.1%. The combination of a short and soft cervix, however, demonstrated 100% sensitivity and 98.5% specificity for sPTB before 34 weeks, indicating its robust predictive ability. For sPTB before 37 weeks, the combined parameter showed a higher positive predictive value (PPV) of 80% compared to 25% for a short cervix alone and 64.3% for a soft cervix alone. The high negative predictive value (NPV) of the combined parameter (100% for sPTB before 34 weeks and 92.6% for sPTB before 37 weeks) further highlights its utility in ruling out sPTB risk in low-risk

cases. The likelihood ratios also support the superiority of the combined parameter, with a positive likelihood ratio (LR+) of 66.67 for sPTB before 34 weeks, compared to 45.33 for a short cervix alone.

The findings of this study have important clinical implications. Traditionally, cervical length has been used as the primary screening tool for sPTB. However, its limited sensitivity necessitates the incorporation of additional parameters to improve predictive accuracy. Shear wave elastography, which provides quantitative measurements of cervical stiffness, complements cervical length assessment by evaluating the biomechanical changes in the cervix [10].

The ability of the combined short and soft cervix to predict sPTB with high sensitivity and specificity allows clinicians to better stratify risk and tailor management strategies. For example, interventions such as cervical cerclage, vaginal progesterone, or lifestyle modifications could be selectively offered to women identified as high risk based on these combined parameters, potentially improving perinatal outcomes [11]. A major strength of this study is its prospective design and the use of an integrated ultrasound system that allowed simultaneous measurement of cervical length and stiffness, minimizing operator variability. Additionally, the study adhered to strict inclusion and exclusion criteria, ensuring a homogenous sample.

CONCLUSION

Our study demonstrates that combining cervical length and cervical stiffness measurements significantly enhances the predictive accuracy for sPTB compared to either parameter alone. The high sensitivity and specificity of the combined parameter make it a valuable tool in prenatal care, particularly for identifying high-risk pregnancies.

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