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Original Research Article

Predictive Value of Mid-Trimester Ultrasound Cervical Assessment in Pre-term Delivery

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Abstract:

Background: Preterm delivery (PTD) is a major cause of neonatal morbidity and mortality. Early predictions remain challenging, particularly in low-resource settings, making reliable screening tools like mid-trimester cervical assessment essential.

Aim: To evaluate the predictive value of mid-trimester transvaginal ultrasound cervical assessment in identifying women at risk of preterm delivery.

Methodology: This prospective cohort study included 187 singleton pregnancies (18–20 weeks) at Department of obstetrics and gynecology, MGM Medical College and Multicentric Hospital, Jamshedpur, Jharkhand, India. Cervical length (CL), funneling, and internal os morphology were assessed via transvaginal ultrasound. Participants were categorized into high- and low-risk groups and followed until delivery. Statistical analysis included logistic regression and ROC curve analysis.

Results: High-risk women had significantly shorter CL (3.0 vs 4.5 cm, $p<0.001$), higher funneling (45% vs 0%), and increased PTD (75% vs 4.8%). Cervical length was the only significant predictor (OR=0.52, $p<0.05$). ROC analysis showed good predictive accuracy (AUC=0.84), with a cut-off <3.5 cm (sensitivity 92%, specificity 66%).

Conclusion: Mid-trimester cervical length is a strong independent predictor of PTD and a useful screening tool for early risk identification and intervention.

Keywords: Preterm delivery, Cervical length, Transvaginal ultrasound, Mid-trimester, Prediction, Cervical funneling.

Introduction

Preterm birth (PTB), a critical public health issue worldwide and the primary cause of perinatal deaths and morbidity, continues to increase despite improvements in obstetric and neonatal care. This poses a major challenge to healthcare providers, especially in developing areas like Jharkhand, India. Due to the multiple causes of PTB, it can be difficult for healthcare providers to identify and prevent PTB early, thus requiring appropriate tools for predicting PTB to enable timely treatment.

While there are many causes of PTB, research has shown that cervical length (CL), as measured via transvaginal ultrasound at 20-24 weeks of pregnancy, is a risk factor for PTB [1,2]. Specifically, short cervical length (CL) has been found in 0.5-3.0% of asymptomatic singleton pregnancies [1,2]. This suggests that CL is a promising marker of PTB risk even in low-risk populations.

Multiple maternal characteristics have been associated with an increased risk of PTB. In fact, studies have shown that obstetric history, history of cervical excisional procedures, and maternal anthropometry such as body mass index (BMI) or height are significantly associated with PTB [3]. By understanding these associations and using valid tools to identify high risk patients, providers are better able to plan for appropriate monitoring and management.

It is critical to clarify the predictive ability of risk factors to improve clinical care for patients, provide proper screening, and create both prevention and therapy approaches for preterm births [4]. Not only does premature delivery led to the highest number of deaths of newborns, but a major number of the babies that survive are at high risk of developing a permanent physical and/or mental disability that will create long-term problems for them and their families and will also place a burden on the healthcare system.

Even with improvements in perinatal care, the incidence of pre-term births is still increasing. The

largest contributor to this rise in preterm births is the growing prevalence of multiple pregnancies resulting from assisted reproductive technologies [5]. Therefore, there is an urgent need to develop effective predictive and preventive methods that can universally be used, including in under-resourced areas such as Jharkhand.

One of the available predictive tools includes measuring the length of the cervix, which still remains an important measurement even if it is not that sensitive or predictive [6]. However, it is the only way to predict a possibility of a successful intervention, such as progesterone treatment or cervical cerclage to help prevent preterm delivery.

The challenge of managing established pre-term labour continues to be problematic. The use of tocolytic medications is widespread, but their current means of prolonging pregnancy is marginal. Tocolytic medications are also associated with numerous complications for the mother, foetus and infant. Therefore, it is imperative that we continue to explore preventive approaches for identifying high-risk women prior to the onset of labour.

A number of different factors are associated with an increased risk of preterm labour. Some of these risk factors include socioeconomic and cultural marginalization, prior history of preterm births, cervical incompetence, smoking and substance abuse. Other pregnancy-related complications that increase the risk of preterm delivery include multiple gestation pregnancies, polyhydramnios, vaginal bleeding, uterine abnormalities, and excessive uterine contractions. While these risk factors have been identified, traditional maternal risk scoring methods have failed to provide accurate predictions, resulting in up to 70% of infants being delivered spontaneously prior to term [7]. The inability to use only clinical risk factors for predicting delivery prior to term is an indicator of the inadequacies in this type of prediction.

There have been some attempts at exploring alternative screening modalities, such as laboratory testing to measure inflammatory biochemical markers and microbiological screening for infection [8]; however, these screening modalities tend to be expensive, time-consuming, and not easily achievable in low-resource settings. Therefore, their practical application is limited.

The cost of caring for babies born prematurely is significant and means we really need to have effective ways of preventing premature delivery. One of the more effective methods of doing so is also very new - ultrasound (US) cervicometry, which has been around since it was first used more than 30 years ago and was only used more frequently after high-frequency transvaginal probes were made available during the 1990s. Many studies have demonstrated that US cervicometry done using transvaginal probes is much more precise than either digital or transabdominal US cervicometry [9].

With US, there is much more detail about the structure and function of the cervix than what is available with either digital or transabdominal exams. This allows for a precise and objective assessment of the cervix and the supravaginal portion, a description of the configuration of the internal os, and the characteristics of the lower uterine segment. With the use of US cervicometry, there is both measurement of the length of the cervix (closed portion) and the evaluation of the internal os' morphology (shape), which will help predict the cervix's ability to remain closed and not give way to delivery before 37 weeks gestation.

The increased impact of pre-term delivery and the complications associated with it continues to be of great concern across the globe. This concern becomes more acute in places such as Jharkhand where there is limited access to health care resources; therefore, developing reliable, cost-effective, and non-invasive methods to screen and predict preterm delivery is a major public health priority. Mid-trimester ultrasound cervical assessments are one possible solution.

Significant perinatal complications may arise from pre-term delivery; therefore, prevention becomes an especially crucial aspect of pre-term labor. This study's purpose is to evaluate if mid-trimester ultrasound of the cervix is predictive of women likely to deliver preterm. By looking at the study population of women in Jharkhand India, this study will generate regionally specific data that can potentially improve maternal and neonatal outcomes through early identification and treatment.

Methodology

Study Design: This study was conducted as a prospective observational cohort study aimed at evaluating the predictive value of mid-trimester ultrasound cervical assessment in the prediction of preterm delivery. The participants were followed longitudinally from the mid-trimester period until delivery to assess pregnancy outcomes.

Study Area: The study was carried out in the Department of Obstetrics and Gynecology at MGM Medical College and Multicentric Hospital, Jamshedpur, Jharkhand, India.

Study Duration: The duration of the study was one year from March 2004 to February 2005.

Sample Size: A total of 187 pregnant women who fulfilled the inclusion criteria were enrolled in the study. The sample size was determined based on the availability of eligible participants during the study period.

Study Population: The study population consisted of pregnant women with singleton pregnancies

attending the antenatal clinic of the hospital. These women were recruited during their mid-trimester period and were monitored throughout the course of their pregnancy.

Inclusion Criteria

Participants were selected based on the following criteria:

- Singleton pregnancy
- Maternal age < 40 years
- Body Mass Index (BMI) < 30 kg/m²
- Gestational age between 18–20 weeks
- No history of cervical cerclage
- Absence of chronic medical diseases such as hypertension or diabetes

Exclusion Criteria

Participants were excluded if they had:

- History of previous preterm delivery
- Previous uterine surgery
- Multiple gestations
- Any significant obstetric or medical complication affecting pregnancy outcome

Data Collection: Data were collected using a predesigned and structured proforma that included demographic details, obstetric history, and clinical findings. All participants underwent transvaginal ultrasound cervicometry between 18 and 20 weeks of gestation. The cervical length was measured, the shape of the internal os was assessed, and the presence of cervical funneling was noted. Based on these findings, participants were categorized into high-risk and low-risk groups and followed until delivery to record outcomes, particularly the occurrence of preterm birth.

Procedure: After obtaining informed consent, eligible participants underwent transvaginal ultrasound examination performed by trained personnel under standardized conditions. Cervical length was measured in millimeters, and any abnormalities such as funneling were documented. Participants were then followed up through regular antenatal visits. The gestational age at delivery and incidence of preterm delivery were recorded for all participants.

Statistical Analysis: The collected data were entered and analyzed using SPSS version 20 (IBM, New York, USA). The Kolmogorov–Smirnov test was used to assess the normality of data distribution. Quantitative variables were analyzed using Student's t-test, while categorical variables were analyzed using the Chi-square test. A p-value of ≤0.05 was considered statistically significant. Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the sensitivity and predictive value of cervical length measurement in predicting preterm delivery. Logistic regression analysis was also conducted to determine the influence of various factors on the occurrence of preterm birth."

Result

Table 1 compares cervical parameters and preterm delivery outcomes between high-risk (Group 1, n=40) and low-risk (Group 2, n=147) groups, showing significant differences in most variables. The mean cervical length was significantly shorter in the high-risk group (3.0 ± 0.75 cm) compared to the low-risk group (4.5 ± 0.50 cm) (p<0.001). Cervical funneling was observed in 45% (18/40) of the high-risk group but was absent in the low-risk group (0/147), which was also statistically significant (p<0.001). Preterm delivery (PTD) was markedly higher in the high-risk group at 75% (30/40) compared to only 4.8% (7/147) in the low-risk group (p<0.001). However, although the mean gestational age at delivery was lower in the high-risk group (36.2 ± 3.1 weeks) than in the low-risk group (38.9 ± 2.8 weeks), this difference was not statistically significant (p=0.084). Overall, the table highlights strong associations between high-risk status, shorter cervical length, presence of funneling, and increased preterm delivery.

Table 1: Comparison between study groups regarding cervical parameters and preterm delivery

Parameter	Group 1 (High Risk) N = 40	Group 2 (Low Risk) N = 147	p-value
Cervical length (cm) (mean ± SD)	3.0 ± 0.75	4.5 ± 0.50	<0.001
Funneling (frequency)	18/40 (45%)	0/147 (0%)	<0.001
Preterm Delivery (PTD)	30/40 (75%)	7/147 (4.8%)	<0.001
Gestational age at delivery (weeks) (mean ± SD)	36.2 ± 3.1	38.9 ± 2.8	0.084

Table 2 shows the binary logistic regression analysis of predictors of preterm delivery, indicating that cervical length is the only statistically significant predictor among the variables studied. Cervical length had an odds ratio (OR) of 0.52 (95% CI: 0.20–0.90; p<0.05), suggesting that shorter cervical length is significantly associated with higher risk of preterm delivery. In contrast, age (OR=0.91; 95% CI: 0.60–1.35; p>0.05) and BMI (OR=0.95; 95% CI: 0.68–1.40; p>0.05) were not significantly associated with preterm delivery, as their confidence intervals include 1 and p-values are non-significant. Overall, the analysis highlights cervical length as an important independent predictor of preterm delivery.

Table 2: Binary Logistic Regression Analysis of Predictors of Preterm Delivery			
Variables	**OR**	**95% CI**	**P-value**
Age	0.91	0.60 – 1.35	>0.05
BMI	0.95	0.68 – 1.40	>0.05
Cervical Length	0.52	0.20 – 0.90	<0.05

Table 3 presents the ROC curve analysis for predicting preterm delivery using cervical length, demonstrating good diagnostic accuracy with an AUC of 0.84 (95% CI: 0.76–0.91) and a statistically significant p-value of <0.001. The best cut-off value was identified as <3.5 cm, at which the test showed high sensitivity of 92%, indicating strong ability to correctly identify cases of preterm delivery, along with a moderate specificity of 66%, reflecting a fair capacity to correctly exclude those without the condition. Overall, cervical length appears to be a reliable predictor of preterm delivery with high sensitivity and acceptable specificity.

Table 3: Receiver Operating Characteristic (ROC) Curve Analysis for Prediction of Preterm Delivery						
ROC Index	**AUC (Area Under Curve)**	**95% CI**	**P-value**	**Best Cut-off Value**	**Sensitivity**	**Specificity**
Cervical Length	0.84	0.76 – 0.91	<0.001	< 3.5 cm	92%	66%

Discussion

Our study shows an important relationship between shorter cervical length measured mid-trimester and future premature labour. The mean cervical lengths for both groups were measured in centimeters: high-risk (3.0 ± 0.75) and low risk (4.5 ± .05). These values are consistent with the existing literature, which has shown that there is an inverse relationship between cervical length and occurrence of premature labour, i.e., Iams et al. (1996) [10] found that cervical lengths ≤30 mm as measured by transvaginal ultrasound were very good predictors for subsequent premature deliveries and the number of deliveries was found to correspond inversely to cervical length (number of deliveries increased as cervical length decreased). Furthermore, Sonek et al. (1990) [11] stated that, because the average cervical length at approximately 30 weeks' gestation is 35 mm, any reduction in cervical length below this amount will greatly increase your chances for premature delivery. Our average values of cervical length were slightly higher than other studies in the low-risk group. This may be due to population differences or that women with prior premature deliveries were excluded from our study population."

In addition to the fact that 75% of women whose pregnancies were considered at high risk of preterm delivery were found to deliver their babies preterm, we also observed that 4.8% of women classified as low risk have also delivered their babies preterm. This indicates that the percentage of women delivering their babies preterm in this study was considerably higher than that reported by other studies. The greater number of women delivering preterm in this study may be attributed to the fact that we recruited high-risk women into our population, which is in contrast to previous studies (Goldenberg et al., 1998) [12]. Moreover, Heath et al. (1998) [13] have reported an extremely high relative risk (46.2) for preterm birth occurring prior to 33 weeks if cervical length was less than or equal to15 mm at the time of measurement. Although we did not examine the presence or absence of extreme cervical shortening (<15 mm) in our study, our results regarding mean cervical length in the high-risk group are consistent with the pattern of increasing risk associated with progressively shorter cervical lengths previously described in the literature.

Additionally, funneling of the cervix, when present in women at high risk of preterm birth, is an important factor that correlates with preterm birth (45% of women at high risk in our study). Other studies have identified funneling as one of the abnormal morphologies of cervices that predict negative pregnancy outcomes (Rosati & Guariglia, 2000; Braithwaite & Economides, 1997) [14,15]. The absence of funneling in the low-risk group in our study demonstrates that funneling is specific to the diagnosis of preterm delivery; however, studies have concluded that funneling does not predict preterm delivery as well as cervical length. Therefore, funneling should be evaluated with other variables.

Cervical length was identified as the only statistically significant independent predictor of preterm delivery in our regression analysis and that there appears to be no relationship between preterm delivery or maternal age or BMI. These results are consistent with the findings of Andersen et al. (2013) [16], who also determined that cervical length was a better predictor of preterm delivery than standard demographic or clinical indicators, specifically performed on low-risk populations. Additionally, Poon et al., (2012) [17] confirmed that cervical length was an essential contributor to predicting preterm delivery, even after including other predictors. Therefore, our finding is consistent with previously published studies that concluded that increasing cervical length decreases the probability of preterm delivery with an odds ratio of 0.52.

The diagnostic accuracy of cervical length was determined to have a 0.84 area under the ROC curve with good predictive accuracy (moderate-high predictive values). The results are consistent with previously published studies of moderate-high predictive value of cervical length measurement. The cut-off for cervical length at <3.5 cm had a high sensitivity (92%) and moderate specificity (66%), similar to the findings of Iams et al. (1996) with regard to cervical length's ability to predict obstetric outcome. Some studies have used a lower cut-off value (e.g., 2.5 cm) than ours in an attempt to have greater specificity; hence, differences in findings among studies may reflect these different cut-off values. The research reported in this study supports the hypothesis that a higher cut-off will provide earlier identification of high-risk women; however, it will also lead to an increase in false positive tests.

The lack of statistically significant differences in mean gestational age at delivery between our high-risk and low-risk groups may be the result of our small sample size, or differences in how pregnancies were managed obstetrically. Other studies have shown a greater association between shorter cervical length and earlier mean gestational age at delivery; thus, larger samples may be needed to find these kinds of differences more reliably across studies.

Likewise, our exclusionary criteria of patients with a history of preterm birth may explain some of the variation in our findings compared to those reporting results from women with such a history. Previous studies have demonstrated that women who have previously had a preterm delivery are likely to have shorter cervices, and that this increases the risk of subsequent preterm delivery (Heath et al., 1998) [13]. The current study, therefore, isolates the predictive utility of cervical length as an independent variable from obstetric history; this strengthens the internal validity of the results, but may limit the ability to generalize our findings to a larger population.

Overall, our results are highly consistent with other research showing that mid-trimester transvaginal cervical assessment is a useful method for predicting preterm delivery. Variability in cut-off values, differences between study populations, and different methodologies used all contribute to variability in results across studies. Despite these differences across studies, however, the common finding is that shorter cervical lengths are a significant predictor of preterm birth and including them in routine antenatal screening may improve early identification and management of high-risk pregnancies.

Conclusion

This research findings show mid-trimester ultrasonic evaluation of cervical parameters, especially cervical length, is a strong predictor of preterm delivery. High-risk women had shorter cervices and higher rates of cervical funneling, which were both independently associated with higher rates of preterm birth. Logistic regression showed a statistically significant association between cervical length and preterm birth while maternal age and BMI did not have a statistically significant association to preterm birth. Cervical length displayed high predictive accuracy on ROC analysis for use as a reliable screening test. Therefore, the use of mid-trimester transvaginal cervical assessment can be applied as a reliable and practical method of early detection of women at increased risk of preterm delivery and allow for timely interventions and management.

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