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Analysis of Labor Pattern in Primigravidae: A Customized Cervical Dilatation Curve

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Abstract

Background:
Conventional labor curves, particularly Friedman's model, do not accurately represent labor progression in all populations, especially among Indian primigravidae. Updated models like Zhang's curve indicate a more gradual early labor phase, necessitating population-specific adaptations to tools like the partograph.Given the significant influence of factors like ethnicity, maternal age, BMI, gestational age, and the use of epidurals on labor progression, there is a growing need to customize labor monitoring tools like the partogram for specific populations and thus reduce unnecessary interventions without compromising maternal or neonatal outcomes
Objectives:
To evaluate cervical dilatation patterns in low-risk Indian primigravidae and develop a customized cervical dilatation curve tailored to this demographic.
Methods:
A prospective observational study was conducted at a tertiary care center in South India from March to October 2021. A total of 152 primigravidae with spontaneous labor and favourable outcomes were monitored. Cervical dilatation was recorded periodically, and labor progression was analysed using nonlinear regression models. Comparisons were made with Friedman and Zhang curves. Statistical analysis employed SPSS v20 with significance at $p < 0.05$.
Results:
The mean rate of cervical dilatation during active labor was 1.5 cm/hr. Active labor reliably began at 6 cm, not 4 cm as per traditional models. An exponential model (Dilatation = 6.24 * e^0.018x) closely fit the observed data. Early labor showed slower progression (0.5–1.0 cm/hr), and prolonged latent phases (up to 58 hours) were associated with normal vaginal delivery.
Conclusion:
The findings underscore the inadequacy of applying Friedman's curve to Indian primigravidae. Recognizing active labor onset at 6 cm and accepting slower early dilation may reduce unnecessary interventions. A population-specific labour curve is recommended to improve maternal and neonatal outcomes.

Keywords: Cervical dilatation, labor curve, primigravida, Friedman curve, partograph, Indian population, customized cervicograph.

INTRODUCTION

The partogram is a visual tool traditionally used to monitor labor progress and identify deviations in maternal or fetal health [1]. Its conventional design is based on Friedman's labor curve developed in the 1950s, which outlines a linear cervical dilatation pattern assumed to apply universally. However, newer research suggests that this model may not reflect the actual progression of labor, particularly in early stages, across all populations.

In 2010, Zhang et al. proposed a revised labor curve (Figure 1) that demonstrates a slower and more gradual cervical dilatation pattern compared to Friedman's (Figure 2), particularly before reaching active labor. This more dynamic model better aligns with contemporary labor data and challenges the long-held notion of a uniform progression curve for all women [2].

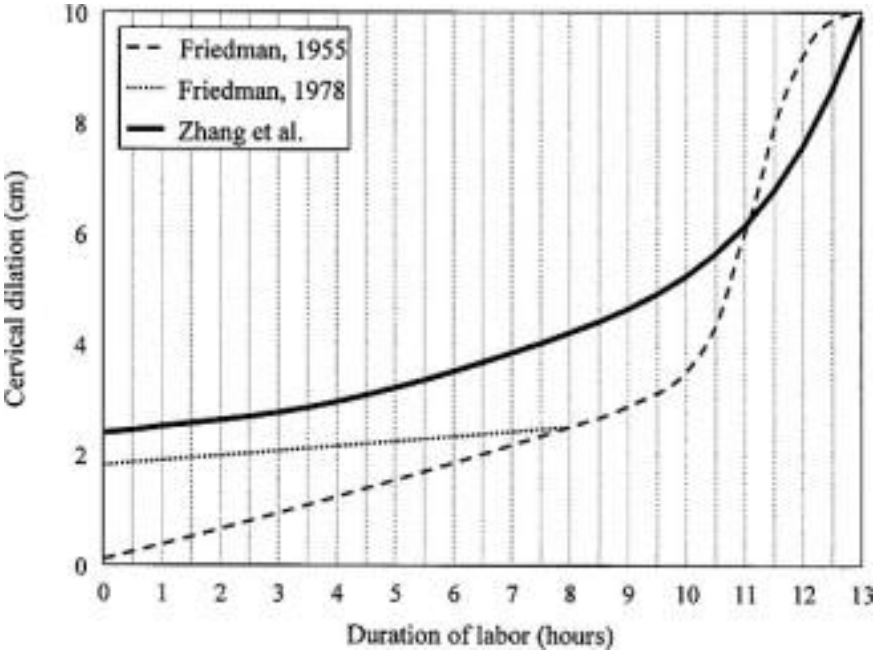

Figure 1: Friedman and Zhang curve for normal labour

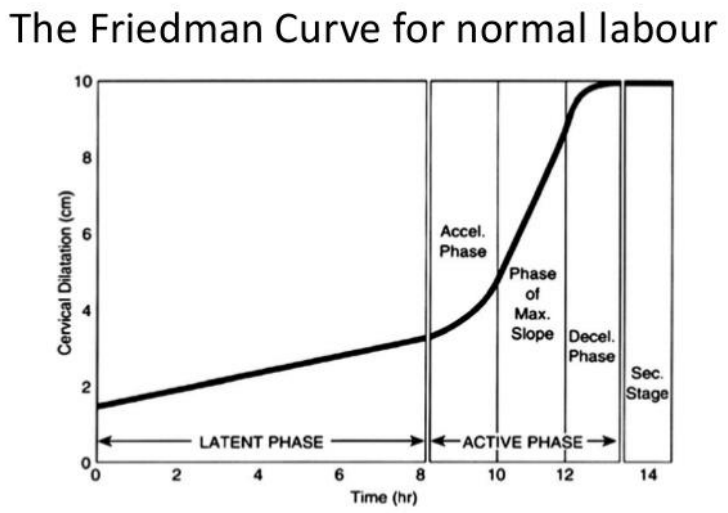

Figure 2: Friedman curve for normal labour.

Given the significant influence of factors like ethnicity, maternal age, BMI, gestational age, and the use of epidurals on labor progression, there is a growing need to customize labor monitoring tools like the partogram for specific populations [3,4]. The rising cesarean section rates among primigravidae—often attributed to "labor dystocia"—highlight the urgency for updating current guidelines. Adopting modern, population-specific labor curves could reduce unnecessary interventions without compromising maternal or neonatal outcomes [5].

Materials and Methods

This was a prospective observational study conducted in the Department of Obstetrics and Gynaecology at K.S. Hegde Medical College and Hospital, a tertiary care center in Dakshina Karnataka, from March 2021 to October 2021. The study included antenatal women who were primigravidae and met the following inclusion criteria: age between 18 and 34 years, body mass index (BMI) ranging from 19 to 25, height above 145 cm, gestational age between 37 weeks and

41 weeks, singleton pregnancy, spontaneous onset of labor, vertex presentation, and estimated fetal weight between 2.5 and 3.5 kg as determined by Hadlock formula during antenatal ultrasonography at term. Only patients who delivered vaginally with good maternal and neonatal outcomes were included.

Exclusion criteria were women with precipitate labor, preterm delivery, intrauterine growth restriction (IUGR), epidural analgesia, malpresentation (confirmed on antenatal scan), cesarean section, induced or augmented labor, and those with medical or obstetric complications.

Outcome Measures

Primary outcomes included:

- Rate of cervical dilatation during the active phase.
- Creation of a customized cervicograph based on the observed mean rate of cervical dilatation.

Secondary outcome:

- Comparative evaluation of the present study's findings with established labor patterns described by Friedman and Zhang.

Sample Size and Statistical Analysis

The required sample size was calculated as 116, using a standard deviation (SD) of 0.55 for the mean cervical dilatation rate as observed in Nivethitha et al. [4] study, with a margin of error of 0.1 and 95% confidence interval, using 'nMaster' software version 2.

Data collection was performed using predesigned case record forms and subsequently entered in Microsoft Excel. Nonlinear regression analysis was applied to model cervical dilatation over time, and intervals between dilatation points were calculated using SPSS software version 20. Student's *t*-test was used to compare results with established standards, and a p value < 0.05 was considered statistically significant.

Procedure

Our study included a total of 152 antenatal women after the application of inclusion and exclusion criteria. Labor progress was charted using Microsoft Excel, with the duration of labor on the X-axis (hours) and cervical dilatation on the Y-axis (cm). The partogram was initiated at the onset of regular uterine contractions, designated as zero hour, in line with Friedman's original study.

Per vaginal examinations were conducted every four hours during the first stage and hourly during the second stage, with increased frequency as required. In cases of premature rupture of membranes (PROM), patients who were already in labor were included. Routine monitoring was carried out as follows:

- Fetal heart rate: half-hourly in latent phase, continuous cardiotocography (CTG) in active phase.
- Uterine contractions and maternal pulse: half-hourly.
- Maternal temperature: every two hours.
- Blood pressure: every four hours.

Neonatal outcomes were assessed using APGAR scores at 1 and 5 minutes and any NICU admissions were documented. Post-delivery, maternal parameters were monitored every 15 minutes for 1 hour in the fourth stage of labor, and extended if required.

Ethical Considerations

As this was an observational study, no interventions were introduced and no additional ethical clearance was deemed necessary. Informed consent was obtained from all participants prior to data collection.

RESULTS

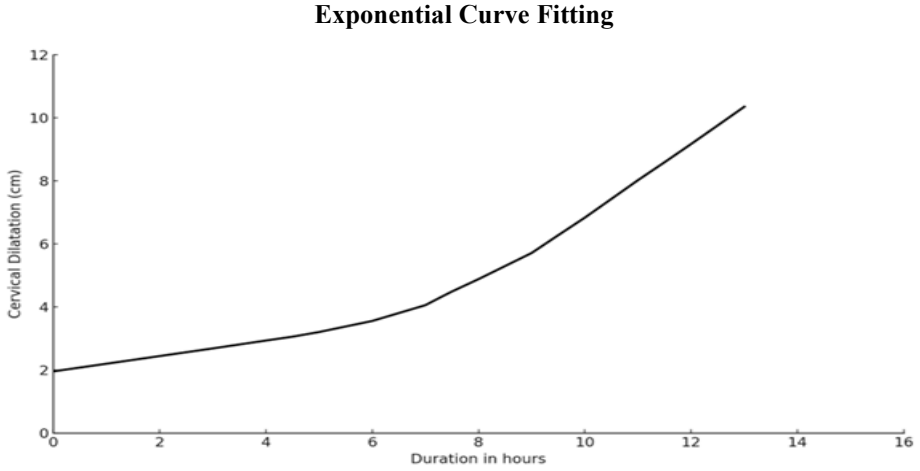

Figure 3: Cervical dilation in centimeters vs progression of labour in hours

Fitted Model: Dilatation = 6.24 * e^ (0.018x)
This closely resembles the model proposed in the study conducted by Nivethitha P et al. [4] (Dilatation = 1.8659e^0.13086x). The strong fit ($R^2 \approx 0.81$ in source study) confirms the validity of exponential modeling for this population.

DISCUSSION

The data reveals a pattern consistent with the findings of Nivethitha et al [4], with a slower early progression and active phase beginning at approximately 5 cm. This deviates from traditional Friedman curves which begin active labor at 4 cm and progress at 3 cm/hour. The mean rate in this dataset is approximately 1.5 cm/hour in active phase, aligning with customized Indian norms.

Onset of active phase: Multiple Indian series report that the true active phase (faster dilation) generally begins at ~6 cm in nulliparas. Shukla *et al.*[6] found the acceleration point to be at 6 cm in most primigravidae. Similarly, Jena *et al.* [3]observed that "fast cervical dilatation" (>1.5 cm/hr) typically starts around 6 cm. In practical terms, this implies that delays before 6 cm should often be regarded as normal latent labour rather than arrest of progress.

Dilation rates: Indian cohorts consistently show slower early dilation than Friedman's norms. In study by Jenna et al.[3], the mean rate between 4–6 cm was only ~1.8 cm/hr (median lower), while between 6–10 cm it rose to ~3.2 cm/hr. For spontaneous labours, Shukla *et al.*[6] found the average rate 0.5 cm/hr between 4–6 cm and ~1.0 cm/hr beyond 6 cms. These rates are comparable to Zhang's observations that half of nulliparas dilate <1 cm/hr until 5–6 cm[4]

Labour duration variability: Indian data show wide variability. Bhat and Panicker (Coimbatore) reported that many primiparas reached 95th-percentile labour durations multiple times without intervention[5]. For example, some women took up to 18–26 hours to dilate from 2 to 3 cm, yet still delivered vaginally. Likewise, Shukla *et al.* [6]observed one case with a 58-hour latent phase that ultimately delivered vaginally. These findings suggest current labour norms may under-recognize what is physiologically acceptable in this population.

Implications for Labor Management in Indian Primigravida Women

Emerging evidence strongly supports redefining the active labor threshold for Indian primigravidae to 6 cm cervical dilation, rather than the traditional 4 cm benchmark. This change reflects updated research showing a notable acceleration in dilation at 5–6 cm, aligning with findings by Zhang *et al.* and Indian datasets—thereby helping prevent premature classifications of labor arrest and reducing unwarranted interventions[3,6].

The conventional alert line of 1 cm/hour on partographs may not be realistic for first-time mothers, especially during latent labor. Recent Indian research reported average early dilation rates between 0.5–1.0 cm/hr, and even sustained dilation of 0.6 cm/hr can result in spontaneous vaginal delivery[8]. Adjusting expectations to these slower benchmarks can prevent unnecessary augmentation or caesarean sections.

Management of the latent phase also requires patience. Instances of latent labor extending to 58 hours have been reported without adverse outcomes[8]. Thus, expectant management involving hydration, analgesia, and monitoring is preferable. Intervention should be reserved for clear lack of progress during the active phase (post-6 cm).

For induced labor, clinicians should optimize supportive care—such as adequate oxytocin use and hydration—before diagnosing a failed induction. Close monitoring using continuous fetal monitoring (CTG) is advised due to increased rates of stalling and intervention in these cases[8].

Further, population-specific factors like ethnicity, maternal height, BMI, and local clinical practices significantly impact labor progression[9]. This underscores the need for India-specific labor management guidelines, including localized modifications to traditional tools like the partograph, or adopting alternatives tailored to regional norms.

Despite innovations like the WHO Labour Care Guide, which initiates the active phase at 5 cm, recent trials in India have found it to be no more effective than the modified WHO partograph in terms of maternal and neonatal outcomes[5]. Therefore, it is best employed alongside individualized clinical judgment, rather than rigid adherence to prescribed thresholds.

CONCLUSION

This study offers compelling evidence for revising conventional labor management protocols for Indian primigravidae. The traditional Friedman-based model, which defines active labor from 4 cm cervical dilatation and assumes linear progression, appears outdated when applied to contemporary Indian populations. The findings from this prospective observational study support a shift toward recognizing the onset of active labor at 6 cm, aligning with recent global and Indian research. Early cervical dilation was observed to occur more gradually, with rates between 0.5–1.5 cm/hr., and instances of prolonged latent phases—even up to 58 hours—still resulting in successful vaginal delivery.

The exponential modeling applied to this cohort demonstrated a better fit to actual labor progression, especially during the transition from latent to active labor. By adopting population-specific labor curves, particularly in partograph interpretation, clinicians can reduce unnecessary interventions such as augmentation or cesarean sections.

The study underscores the importance of individualized, evidence-based labor monitoring, emphasizing patience and clinical judgment over rigid benchmarks. Redefining active labor thresholds and allowing for variability in progression will help improve maternal and neonatal outcomes while minimizing overtreatment. These findings strongly advocate for the implementation of India-tailored labor guidelines grounded in robust, population-specific data.

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