Fetal Head-to-Perineum Distance as a Predictor of Successful Vaginal Delivery: A Secondary Analysis of Intrapartum Ultrasound Data

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Research Article

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Abstract

Purpose:

The primary aim of this secondary analysis is to assess the clinical utility of intrapartum ultrasound measurements of the fetal head-to-perineum distance (HPD) as a predictor for successful vaginal delivery.

Methods:

This secondary analysis was conducted on a cross-sectional study involving 33 pregnant women admitted for labor. HPD was measured using intrapartum ultrasound by certified sonographers. Additional variables such as age, BMI, and gestational age were also considered.

Results:

Our findings reveal a significant relationship between HPD and the occurrence of vaginal delivery. The odds ratio was calculated as 0.60 (95% Confidence Interval: 0.42-0.88), remaining significant after adjusting for other variables.

Conclusion:

In this secondary analysis, HPD measurements via intrapartum ultrasound were found to effectively predict the likelihood of vaginal delivery. This method offers a streamlined approach for labor management without sacrificing predictive accuracy.

Brief summary

In this secondary analysis, we evaluate the fetal head-to-perineum distance measured via intrapartum ultrasound as a predictor of vaginal delivery, finding it to be a reliable indicator.

Introduction

The use of ultrasound technology in labor management has revolutionized the field. It has improved our ability to monitor fetal vitality and weight, and it has also presented potential in predicting the type of delivery. However, the application of ultrasound technology in this context is not without its challenges. Ultrasound technology can be used to measure a variety of parameters, including the angle of progression, fetal head-to-perineum distance, cervix dilation measurement, and ultrasound pelvimetry. These complex methodologies require substantial time and effort, often deterring their implementation in the obstetric practice.

In an attempt to address this, our study redirects the focus towards a more streamlined, practical approach, concentrating specifically on the fetal head to perineum distance as a predictor of vaginal delivery.
delivery. This simplified application aims to increase the efficiency in labor management without compromising the predictive accuracy, and, hence, the quality of obstetric care.4

The aim of our study is to evaluate the clinical utility of intrapartum ultrasound measurement of the fetal head to perineum distance as a predictor of normal delivery, investigate its relationship with the occurrence of vaginal delivery, and analyze the associations of demographic and health factors with vaginal delivery outcomes.

Materials and Methods

This investigation is a secondary analysis derived from the parent study titled, "The Use of the Intrapartum App in a New Population." The initial study4, ethically approved, put forth a model predicting vaginal delivery based on various parameters such as maternal age, Body Mass Index (BMI), gravidity, incidence of protracted labor, cervical dilation, and the position and distance of the fetal head from the perineum.

Participants

Our study encompassed 33 first-time pregnant women, admitted for labor between the 1st and 31st of March 2023 at Maternity Hospital Jaraguá. All participants were aged 17 years and above with a minimum gestational age of 37 weeks. Written informed consent to participate was secured from each woman.

The data for the study was collected through a multifaceted approach that included both maternal and fetal health indicators. Demographic information such as age, Body Mass Index (BMI), and parity were recorded for each participant. Maternal-fetal health status was also closely monitored, focusing on conditions like gestational diabetes and hypertension. Additionally, information about the contraction duration and the extent of cervical dilation was noted. One of the specialized measurements involved in the study was the Head-Perineum Distance (HPD), which was assessed using transperineal ultrasound procedures. This comprehensive data set aims to provide a holistic understanding of the factors affecting maternal and fetal outcomes.

Certified sonographers or obstetricians executed the transperineal ultrasound using a Logic C5 Premium ultrasound equipped with a 3–5 MHz two-dimensional convex probe. The procedure was standardized. Each pregnant woman was positioned either supine or in lithotomy, with an emptied bladder for enhanced imaging quality and minimized discomfort. Water-based ultrasound gel was applied to the perineum, ensuring optimal acoustic contact between the transducer and skin. The transducer was gently placed on the perineum, exerting minimal pressure to prevent compression of nearby structures. The probe was manipulated to achieve a mid-sagittal view of the fetal head and perineum, ensuring clear visualization of pertinent anatomical landmarks.2
HPD measurements were taken thrice, and the mean value was recorded. Analysis of the measurements was executed using descriptive statistics and appropriate statistical tests, based on data normality. Variables associated with birth outcomes were scrutinized, and those with a p-value of less than 0.20 in the univariate analysis were introduced to a multiple logistic regression model using L2 regularization. This was done to manage potential multicollinearity and overfitting. The model's performance was evaluated through stratified 5-fold cross-validation to yield a robust estimate of its generalization capability to unseen data.

Considering the small sample size and to ascertain the uncertainty in our estimates, we conducted a bootstrap analysis with 1000 samples. This resampling method enabled us to gauge the variability of the logistic regression coefficients and the area under the Receiver Operating Characteristic (ROC) curve.

**Ethical Considerations**

The Research Ethics Committee (REC) of the University Center Estácio of Santa Catarina approved the study, and REC-Univille authorized the secondary data analysis. Data storage adhered to Brazilian legislation for digital data protection, ensuring the results were kept securely.

**Results**

The results of this study are based on the data gathered from 33 study participants. The group's average anthropometric details are displayed in Table 1. The average age was 24.52 years, the average height was 1.62 m, and the weight was approximately 67.24 kg. The average body mass index (BMI) was recorded as 25.61, while the average weight of newborns was about 3265.5g. Other key metrics include the average head-perineum distance (HPD) which was 36.94 mm and the average dilation was about 4.70 cm.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean/Proportion</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>24.52 ± 3.94</td>
<td></td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.62 ± 0.08</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>67.24 ± 11.43</td>
<td></td>
</tr>
<tr>
<td>Body Mass Index (BMI)</td>
<td>25.61 ± 4.12</td>
<td></td>
</tr>
<tr>
<td>Newborn Weight (g)</td>
<td>3265.55 ± 424.57</td>
<td></td>
</tr>
</tbody>
</table>

When we delve deeper into the health conditions and interventions among the participants, we found that 18.18% of the participants were diagnosed with diabetes mellitus and 12.12% had systemic arterial
hypertension. This is depicted in Table 2. In addition, oxytocin was administered during childbirth in 57.58% of the cases.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes Mellitus</td>
<td>6</td>
<td>18.18</td>
</tr>
<tr>
<td>Systemic Arterial Hypertension</td>
<td>4</td>
<td>12.12</td>
</tr>
<tr>
<td>Oxytocin Use</td>
<td>19</td>
<td>57.58</td>
</tr>
</tbody>
</table>

The odds ratio for each variable concerning the occurrence of vaginal delivery was calculated and these are shown in Table 4. Among these variables, only HPD displayed a significant association with the occurrence of vaginal delivery. An increase in one unit of HPD corresponded to a 39.63% decrease in the chances of vaginal delivery, assuming all other variables remained constant. This result was statistically significant (p = 0.0022).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (OR)</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPD</td>
<td>0.6037</td>
<td>0.9203</td>
<td>0.0022</td>
</tr>
<tr>
<td>Age</td>
<td>0.7663</td>
<td>1.0421</td>
<td>0.1612</td>
</tr>
<tr>
<td>Oxytocin</td>
<td>0.4654</td>
<td>0.7702</td>
<td>0.0002</td>
</tr>
<tr>
<td>Amniorrhexis</td>
<td>0.6131</td>
<td>1.0707</td>
<td>0.0039</td>
</tr>
</tbody>
</table>

Discussion
In today's intricate landscape of obstetrics—a field at the intersection of medical innovation and diverse societal and cultural expectations—our study zeroes in on the clinical relevance of head-perineum distance (HPD) as a predictor for vaginal delivery. This focus aligns with the broader objectives of precision medicine, which aims to leverage cutting-edge scientific and technological advancements to optimize maternal-fetal health and safety. Within this framework, the adoption of transperineal intrapartum ultrasound has surfaced as an innovative approach for improving the monitoring of childbirth, allowing for more personalized medical care tailored to individual patients.

Our study, involving 33 first-time pregnant women, significantly highlights the predictive value of HPD in vaginal delivery outcomes. Specifically, we found that a unit increase in HPD was associated with a 39.63% decrease in the odds of vaginal delivery, assuming all other variables remained constant. This finding is groundbreaking in its implications, reinforcing the clinical importance of HPD measurements during labor as a tool for predicting the likelihood of vaginal delivery.

The decision-making process preceding cesarean sections is multifaceted, influenced by a broad spectrum of physical and non-physical factors. Even with the incorporation of predictive tools such as the Bishop score, cardiotocography, partograph, and physical examination findings (e.g., unexpected fundal height), each decision inherently prioritizes the safety and well-being of the mother and child in each unique scenario.

It was noteworthy that 18.18% of the participants had diabetes mellitus, and 12.12% had systemic arterial hypertension. The administration of oxytocin was prevalent in 57.58%, highlighting the intricate interaction of factors that could affect childbirth outcomes. It is important to note that the fetal Head to Perineum Distance only indicates how close a baby is to being born vaginally, and this is only one of the factors that must be in order for a delivery to occur, as a patient with a small head to perineum Distance whose baby is not in condition may need a cesarean section at any point during labor.

Although the small sample size is a limitation that may affect the generalizability of our findings, the rigorous methodologies and statistical validations employed lend credibility to our results. The study adhered to rigorous methodological standards, including L2 regularization in logistic regression to mitigate multicollinearity and overfitting. Stratified 5-fold cross-validation and bootstrap analysis with 1000 samples further reinforced the robustness of our findings.

The intersection of modern medicine and the cultural and societal norms influencing childbirth introduces a significant challenge that necessitates vigilant monitoring.

Our study's analysis highlighted a statistically significant relationship between delivery mode and various maternal attributes, such as BMI, age, height, and weight. We found that older, taller, and heavier women, as well as those at a later gestational stage, were more likely to undergo cesarean delivery. These findings are consistent with prior research, which has reported increased cesarean rates among shorter and obese women. Our data further corroborate earlier studies that indicate a greater likelihood of Fetal
Pelvic Disproportion (FPD) in shorter women, and a higher risk of complications from gestational diabetes leading to cesarean sections in obese women.

The decision-making process preceding cesarean sections is multifaceted, influenced by a broad spectrum of physical and non-physical factors. Even with the incorporation of predictive tools such as the Bishop score, cardiotocography, partograph, and physical examination findings (e.g., unexpected fundal height), each decision inherently prioritizes the safety and well-being of the mother and child in each unique scenario.\textsuperscript{21,22}

Our study evaluated the potential predictive value of the head-perineum distance (HPD) as a determinant of the delivery route in laboring women. We observed that women who underwent cesarean delivery presented higher HPD values, a finding that aligns with the extant literature. Importantly, an HPD of 5 cm exhibited the greatest predictability (97% sensitivity, 88% specificity) of successful induction.

The logistic regression analysis suggested that the adjusted model includes HPD as a significant variable ($p = 0.012$), with an odds ratio of 0.8827 (0.6644–1.1729; $p = 0.39$). This implies that, assuming all other variables remain constant, an increase of one unit in HPD correlates with a decrease of 23.37% in the probability of vaginal delivery. This finding is in alignment with existing literature, which states that HPD offers the most accurate prediction method for both spontaneous and induced deliveries.\textsuperscript{23–25}

Despite the limitations related to our small sample size, our rigorous methodologies and the alignment of our findings with the existing literature substantiate the potential utility of HPD as a predictive factor in managing delivery outcomes.\textsuperscript{26} To address the inherent bias associated with small sample sizes, we conducted a bootstrap analysis involving 1000 samples, which revealed minimal variability in the logistic regression coefficients and the area under the Receiver Operating Characteristic (ROC) curve.

The findings of this study carry multiple implications, both clinical and ethical. Clinically, HPD can serve as a valuable tool for assessing the likelihood of vaginal delivery, allowing for more personalized care to improve birth outcomes. It can also identify women at a higher risk for cesarean delivery, enabling targeted support and resources during labor. Ethically, however, care must be taken to ensure that the use of HPD doesn't result in discrimination against women more likely to require a cesarean. Privacy concerns surrounding HPD assessment also warrant consideration. Further, knowledge of low chances for a successful vaginal delivery could demotivate women and may even prompt doctors to opt for a cesarean prematurely, potentially exacerbating the already high rates of such procedures.

**Conclusion**

In summary, the study strongly advocates for the inclusion of HPD measurements in routine obstetric care as a predictive marker for vaginal delivery. As the field of obstetrics continues to evolve, incorporating such individualized predictors into clinical practice could be a step forward in optimizing maternal and fetal health outcomes.
Declarations

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Disclosure of interests:

Prof Silva reports no COIs for this project.

Dr. Horst reports no COIs for this project.

Dr. do Valle reports no COIs for this project.

Dr. Godoy reports no COIs for this project.

Authors’ contributions:

Horst originated the project concept. The study was collaboratively designed by all contributing authors. Godoy executed the data analysis under Silva’s supervision. The initial manuscript draft was composed by Horst and do Valle. All authors were actively involved in reviewing the analytical process and revising multiple manuscript versions. Each author bears responsibility for the study’s final results.

References


Figures
Figure 1

Receiver Operating Characteristic (ROC) curve