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Length of second stage of labor and preterm birth in a subsequent pregnancy

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¹

Abstract

Background—During the second stage of labor, it is plausible that the pressure of the fetal head against a completely dilated cervix may lead to changes in the cervical integrity and cervical strength lending it susceptible to premature dilation in a subsequent pregnancy. Therefore, a prolonged second stage of labor has been hypothesized to be a risk factor for cervical insufficiency and spontaneous preterm birth (sPTB).

Objective—To evaluate the effect that the length of second stage of labor in one pregnancy has on the risk of spontaneous preterm birth (sPTB) in a subsequent pregnancy.

Study Design—This was a planned secondary analysis of a large retrospective cohort study of women with two consecutive deliveries at our institution from 2005–2010. Women with a term pregnancy that reached the second stage were included; women with a prior sPTB were excluded. The primary outcome was sPTB <37 weeks. A prolonged second stage was defined as ≥3hrs. Fisher's exact tests were used to compare categorical data. Linear and logistic regression was used to calculate odds.

Results—757 women were included. The overall length of the second stage ranged from 0–7.3 hours. The sPTB rate in a subsequent pregnancy was 8.7%. There was no association between length of second stage (hours) as a continuous variable and sPTB after adjusting for confounders (aOR 0.83 [0.58–1.20]). A prolonged second stage ≥3hrs occurred in 48 (6.3%) women. Women with a second stage ≥3hours were older, less likely to be African American, and were less likely to be overweight or obese as compared to women with a second stage <3 hours. The women with second stage ≥3 hours were more likely to be nulliparous and have a larger neonate. The sPTB risk was not different between a second stage ≥3hrs (10.4%) and <3hrs (7.9%), $p=0.5$. The sPTB risk was; however, modified by mode of delivery in the second stage. There was no difference in sPTB

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rate among women with a vaginal delivery when comparing those with and without a prolonged second stage (7.4 vs. 7.8%, $p=0.9$). There also was no difference among women with a cesarean when comparing those with and without a prolonged second stage (11.8 vs. 14.3%, $p=0.8$). While not statistically significant, the absolute risk of a subsequent sPTB after a cesarean delivery with a second stage ≥ 3 hrs is twice as high as the risk of a sPTB after a vaginal delivery with a second stage ≥ 3 hrs (OR 2.08 [0.32–13.78]).

Conclusions—A prolonged second stage of labor alone does not increase the risk of sPTB in a subsequent pregnancy. Cesarean delivery after a prolonged second stage of labor may confer a possible increased risk. It is important to continue to evaluate potential risk factors for sPTB. If these risk factors are confirmed in future studies, it will aid in the counseling of women and may open the door for therapeutic strategies to be studied among these newly identified “at-risk” women.

Keywords

Cesarean delivery; preterm birth; second stage of labor

Introduction

The preterm birth (PTB) rate has had a marginal decline and most recently was noted to account for 11.4% of all deliveries in 2013^{1,2} down from 11.6% in 2012. This small decline is likely, in part, due to effective strategies and interventions that help decrease PTB among women found to be at highest risk^{3–5}. However, many women with a spontaneous PTB (sPTB) present without any known or identifiable risk factor. This highlights the importance of continued research to investigate other etiologies and risk factors for sPTB.

Our previous work demonstrated an increased risk of spontaneous PTB (sPTB) in a subsequent pregnancy when a full term cesarean delivery is performed in the second stage of labor as compared to when it is performed in the first stage of labor or compared to women with a term vaginal delivery⁶. Prior to this work, a term cesarean delivery in the second stage of labor was not identified as a risk factor for sPTB.

In addition to the mode of delivery in the second stage of labor, a prolonged second stage of labor has been hypothesized to be a risk factor for cervical insufficiency^{7–9}. During the second stage of labor, it is plausible that the pressure of the fetal head against a completely dilated cervix may lead to changes in the cervical integrity and cervical strength. Therefore, a longer second stage of labor, regardless of mode of delivery, may increase the risk for structural cervical injury lending it susceptible to premature dilation and sPTB in a subsequent pregnancy. This theory, however, has not yet been investigated.

The objective of this study was to specifically evaluate the effect that the length of second stage of labor in one pregnancy has on the risk of sPTB in a subsequent pregnancy. Our hypothesis is that women with a longer second stage of labor have an increased risk of subsequent sPTB.

Materials and Methods

This was a planned secondary analysis of a large retrospective cohort study of women with two consecutive deliveries at the Hospital of the University of Pennsylvania from 2005–2010. The original study compared women with a term (>37wks) induction to term spontaneous labor and evaluated rates of subsequent sPTB¹⁰. Institutional Review Board approval was obtained prior to initiating the study.

Our hospital based electronic database was used to identify women with more than one delivery between 2005 and 2010. The first pregnancy during this time period was considered their “index” pregnancy, which may or may not equate to the woman’s first pregnancy as multiparous women were included. The second consecutive pregnancy during this time period was considered to be the subsequent pregnancy if delivery occurred at ≥16 weeks gestation. Patients were included in the study only once. Women were excluded from the parent study if they had a preterm birth in their index pregnancy or if they had a known history of a prior preterm birth. Only women that reached the second stage of labor were included in the analysis of our current study.

The primary outcome was sPTB, defined as spontaneous labor and delivery or preterm premature rupture of membranes <37 weeks gestation. We first evaluated the overall length of the second stage of labor and its effect on sPTB rates in a subsequent pregnancy. We then evaluated various cut-points for length of the second stage of labor and the individual rates of sPTB for those cut-points (<1 hour, <2 hours, ≥2 hours, ≥3 hours, ≥4 hours). Based on distribution of data, our sample size, and clinical utility, a “prolonged” second stage was defined as ≥3 hours. The rates of sPTB in a subsequent pregnancy were then compared between women with a second stage that was ≥3 hours and women with a second stage <3 hours.

Bivariate analyses were performed using chi square and Fisher’s exact tests to compare categorical data. Student’s t tests and Mann Whitney U tests were used to compare parametric and non-parametric data, as appropriate. Linear and logistic regression was used to calculate odds ratios. Multivariable logistic regression was used to adjust for confounders. To build our multivariable model, we included risk factors that had an association with the exposure or outcome at a level of $p < 0.2$. These identified risk factors were evaluated to be confounders or effect modifiers of the model. Any risk factor that was found to have an effect size of at least 10% was retained in the model as a confounder. Using backwards stepwise elimination, we created our final parsimonious model. Confounders maintained in our model were mode of delivery in the index pregnancy and parity. While race was not found to be a confounder, it was retained in the final model given the biological plausibility of being associated with both the exposure and outcome.

Data analysis was performed using STATA 12.0 for Windows (STATA Corporation, College Station, TX). Statistical significance was set at $p < 0.05$. There was a fixed sample size for this study based on the parent study ($n=757$), therefore a post-hoc power analysis was performed. Based on a sPTB rate of 7.9% in the group with a second stage <3 hours ($n=$

709) and a ratio of 15:1, we had greater than 90% power to detect a 2.5 fold difference in sPTB rate for women with a second stage ≥ 3 hours (n=48).

Results

From the original parent study (n=887), there were 757 (85%) women that reached the second stage of labor and were included in the current study.

The overall length of the second stage ranged from 0–7.3 hours (Figure 1). The rate of sPTB in a subsequent pregnancy was 8.7%. There was no significant association between length of second stage as a continuous variable and subsequent sPTB risk even after adjusting for mode of delivery, parity, and race (aOR 0.83 [0.58–1.20], p=0.3).

The sPTB rates by length of the second stage of labor are as follows: <1hr: 8.7%, <2hrs: 8.2%, 2hrs: 7.1%, 3hrs: 10.4%, 4hrs: 8.0%.

There were 48 (6.3%) women that had a prolonged second stage ≥ 3 hours. The demographic characteristics of women with a second stage <3 hours and ≥ 3 hours are compared in Table 1. Women with a second stage ≥ 3 hours were older, less likely to be African American, and were less likely to be overweight or obese as compared to women with a second stage <3 hours. The women with second stage ≥ 3 hours were more likely to be nulliparous and have a larger neonate. The risk of subsequent sPTB was not different between those with a second stage ≥ 3 hours compared to <3 hours (10.4% vs. 7.9%, p=0.5). This remained true after adjusting for confounders including race, mode of delivery, and parity. (aOR 0.83 [0.21–3.36], p=0.8).

The risk of sPTB was modified by the mode of delivery, as noted in the Figure 2. There was no difference in sPTB rate among women with a vaginal delivery when comparing those with and without a prolonged second stage (7.4 vs. 7.8%, p=0.9). There also was no difference among women with a cesarean when comparing those with and without a prolonged second stage (11.8 vs. 14.3%, p=0.8). While not statistically significant, the absolute risk of a subsequent sPTB after a CD with a second stage ≥ 3 hrs is twice as high as the risk of a sPTB after a vaginal delivery with a second stage ≥ 3 hours (OR 2.08 [0.32–13.78], p=0.4). This was unchanged after adjusting for race and parity.

Comment

We evaluated a novel concept of whether the length of time spent in the second stage of labor of a term pregnancy was associated with a higher risk of sPTB in a subsequent pregnancy. A prolonged second stage of labor has been hypothesized to be a contributor to an increased risk of sPTB and cervical insufficiency⁹. We found that overall length of the second stage, as well as a prolonged second stage of labor, does not impact the risk of sPTB. Cesarean delivery in the setting of a prolonged second stage does; however, appear to confer a possible increased risk. While not statistically significant, the risk of sPTB in a subsequent pregnancy is almost two times higher after a cesarean in the setting of a prolonged second stage as compared to a vaginal delivery after a prolonged second stage (14.3% vs. 7.4%).

The plausible explanation for why a difference in sPTB rates may not have been seen when only focusing on the length of time in the second stage may be the fact that the subsequent sPTB risk is mostly driven by mode of delivery in the second stage. As hypothesized in our previous work⁵, unintentional intraoperative surgical procedures including incising the cervix during hysterotomy, cervical extensions, and possibly incorporating the cervix into the closure of the hysterotomy are more common during a second stage cesarean and are plausible contributors to this observed increased sPTB risk. The fact that women with a vaginal delivery have a similar risk of sPTB, regardless of length of second stage, makes it more likely that an event at the time of cesarean is predisposing these women to the higher risk. In an attempt to investigate this hypothesis, we evaluated the sPTB rate among women with and without an extension during cesarean and found no difference in sPTB rate (20.0% vs. 9.1%, $p=0.3$). The lack of statistical difference may be a function of Type II error since there were only 37 women with a cesarean in the second stage. Therefore, this would need to be investigated in future studies.

An important strength of this study is that it was a planned secondary analysis. As such, all data that was required for this planned study was obtained initially at the time of data abstraction. Additionally, this study uses data from multiple pregnancies at one large urban hospital. Obtaining data from one institution limits the practice variation that occurs during labor and delivery that could potentially impact the results.

Limitations of our study include the fixed sample size as this was a secondary analysis. While we had >90% power to detect a 2.5 fold difference in sPTB risk, we are limited by our sample size to see differences that are below 2.5 yet still are clinically important. Therefore, some of the non-significant differences we saw are likely due to Type II error.

The effect that length of time spent in the second stage has on the risk of subsequent sPTB appears to be dependent on the mode of delivery as a relative increase in the sPTB risk was only seen in those with a cesarean after a prolonged second stage. Our findings support our earlier work which found cesarean delivery in the second stage of labor to be a risk factor for sPTB in a subsequent pregnancy. Importantly, since the increased risk of sPTB was not observed in women with a vaginal delivery after a prolonged second stage, our findings from this study lend additional support to the concept that events taking place during a second stage cesarean may be contributors to the observed subsequent sPTB risk. In addition to the continued effort to reduce unintentional surgical injuries, it is important to continue to evaluate potential risk factors for sPTB. If these risk factors are confirmed in future studies, it will aid in the counseling of women and may open the door for therapeutic strategies to be studied among these newly identified “at-risk” women.

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Figure 1.
Distrubution of time spent in the second stage of labor
no: number
hrs: hours

Figure 2.
sPTB rates stratified by mode of delivery
VD: vaginal delivery
CD: cesarean delivery

Table 1

Demographic characteristics between groups

	Second stage <3 hours (n=709)	Second stage ≥ 3 hours (n=48)	p-values
Age (years)	23 [19–29]	29 [21.5–31.5]	0.002
Age categories			
<18 years	60 (8.5)	2 (4.2)	0.1
18–35 years	599 (84.5)	39 (81.3)	
>35 years	50 (7.1)	7 (14.6)	
Race			
African American	524 (77.5)	19 (42.2)	<0.001
Caucasian	106 (15.7)	16 (35.6)	
Other	46 (6.8)	10 (22.2)	
BMI categories			
<25kg/m ²	300 (43.9)	29 (61.7)	0.03
25–29.9 kg/m ²	193 (28.2)	13 (27.7)	
≥ 30 kg/m ²	192 (28.0)	5 (10.6)	
Nulliparous at index pregnancy	414 (58.4)	43 (89.6)	<0.001
Inter-pregnancy interval (years)	1.3 [0.8–2.3]	1.1 [0.8–1.9]	0.2
Gestational age at delivery of index pregnancy (weeks)	38.8 (±2.5)	38.5 (±3.0)	0.4
Birthweight at index pregnancy (g)	3265.3 (±484.7)	3429.5 (±455.7)	0.02
Induction of labor in index pregnancy	476 (67.1)	34 (70.8)	0.6

N(%), Means (±SD), Median [Inter-quartile range]

BMI: Body mass index