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Perinatal Outcomes in the Setting of Active Phase Labor Arrest

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Abstract

Objective—To examine the association between active phase arrest and perinatal outcomes.

Methods—This was a retrospective cohort study of women with term, singleton, cephalic gestations diagnosed with active phase arrest of labor, defined as no cervical change for two hours despite adequate uterine contractions. Women with active phase arrest who underwent a cesarean delivery were compared to those who delivered vaginally and women who delivered vaginally with active phase arrest were compared to those without active phase arrest. The association between active phase arrest, mode of delivery, and perinatal outcomes was evaluated using univariable and multivariable logistic regression models.

Results—We identified 1,014 women with active phase arrest: 33% (335) went on to deliver vaginally and the rest were delivered by cesarean. Cesarean delivery was associated with an increased risk of chorioamnionitis (aOR 3.37, 95% CI [2.21–5.15]), endomyometritis (aOR 48.41, [6.61–354]), postpartum hemorrhage (aOR 5.18, [3.42–7.85]), and severe postpartum hemorrhage (aOR 14.97, [1.77–126]). There were no differences in adverse neonatal outcomes. Among women who delivered vaginally, women with active phase arrest had significantly increased odds of chorioamnionitis (aOR 2.70, [1.22–2.36]), and shoulder dystocia (aOR 2.37, [1.33–4.25]). However, there were no differences in the serious sequelae associated with these outcomes, including neonatal sepsis and Erb's palsy.

Conclusion—Efforts to achieve vaginal delivery in the setting of active phase arrest may reduce the maternal risks associated with cesarean delivery without additional risk to the neonate

Introduction

The cesarean delivery rate in the U.S. continues to rise, reaching 31.1% in 2006, a new all-time high.¹ Arrest in the active phase of labor is a significant contributor to this increase,² and has been shown to raise the risk of cesarean delivery four to six fold.^{3, 4} In 1989 the American College of Obstetricians and Gynecologists (ACOG) recommended the diagnosis of active phase arrest (APA) only be made with no cervical change for a minimum of two hours in the setting of an adequate uterine contraction pattern, defined as contractions with ≥ 200 Montevideo units in a 10 minute period.⁵ However, in clinical practice, cesarean deliveries performed for lack of progress often fail to meet these criteria.⁶ More recent ACOG recommendations on the management of labor dystocia recommend oxytocin administration

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be considered in the setting of arrested labor for effective uterine activity while avoiding fetal compromise.⁷ However, there is little information on the impact of active phase arrest on maternal and neonatal outcomes.

Though ACOG recommends at least a “two hour minimum” before a diagnosis of active phase arrest is considered, recent studies have demonstrated that if women diagnosed with APA are given at least four hours, a majority will go on to achieve vaginal delivery.^{8, 9} In these two studies, Rouse et al report that this protocol appears safe and effective, with low rates of maternal and neonatal complications in all women with APA, with similar rates in those with cesarean and vaginal deliveries. We sought to confirm these findings and evaluate the perinatal outcomes in our cohort of women with active phase arrest.

In order to explore the obstetric management of women with APA as well as to estimate the risks associated with APA, we created two comparison groups. First, we included only women with APA and compared the rates of adverse perinatal outcomes among women who had vaginal deliveries to those who had cesarean deliveries. Next, to examine the risk associated with APA, we compared the outcomes of women diagnosed with APA who achieved vaginal delivery to women without APA who also delivered vaginally.

Methods

We undertook a large retrospective cohort study to examine the rates of adverse perinatal outcomes in women with APA. The cohort included all women with a live, term, cephalic, singleton birth diagnosed with active phase arrest at the University of California, San Francisco (UCSF), who delivered between 1991 and 2001 (n=1,014). We excluded women with multiple gestations, delivery prior to 37 weeks gestation, and anomalous or non-viable fetuses. The Committee on Human Research at UCSF approved the study. The primary independent variable of interest was mode of delivery (vaginal delivery versus cesarean delivery). Maternal outcomes included the frequency of chorioamnionitis, endomyometritis, postpartum hemorrhage (>500ml blood loss for vaginal delivery, >1000 ml for cesarean delivery during the first 24 hours), severe postpartum hemorrhage (>1000ml blood for vaginal delivery and >1500 ml for cesarean delivery) and blood transfusion. Neonatal outcomes included 5 minute Apgar score < 7, acidemia (umbilical cord arterial pH <7.0 or umbilical artery base excess ≤ -12), neonatal sepsis (as diagnosed by the managing pediatrician), and the frequency of admission to the neonatal intensive care unit (NICU).

To evaluate the risks associated with vaginal delivery in the setting of active phase arrest, we constructed an alternative cohort which included all women with term vaginal deliveries that occurred at the University of California, San Francisco (UCSF) from 1991 to 2001 (n=12,901). All women with a term, singleton, live, cephalic, non-anomalous fetus who delivered vaginally during the study period were included. As above, we excluded women with multiple gestations, preterm delivery prior to 37 weeks, cesarean delivery, and anomalous or non-viable fetuses. All deliveries during the study period were performed by the attending physicians, certified nurse midwives, or resident physicians with attending supervision.

For this cohort, the primary independent variable was the diagnosis of active phase arrest. We evaluated several outcomes. Maternal outcomes included frequency of operative vaginal delivery (including forceps and vacuum-assisted vaginal delivery), chorioamnionitis, severe (third or fourth degree) perineal lacerations, endomyometritis, post-partum hemorrhage, and blood transfusion. Neonatal outcomes examined included the frequency of 5 minute Apgar score of < 7, acidemia, neonatal sepsis, admission to the neonatal intensive care unit (NICU), shoulder dystocia, clavicular fracture, Erb’s palsy, and cephalohematoma (as diagnosed by the pediatrician caring for the neonate).

During the study period, the diagnosis of active phase arrest was defined as absence of cervical change during the active phase of labor (≥ 4 cm cervical dilation) for at least 2 hours in the presence of adequate uterine contractions (≥ 200 Montevideo units per 10-minute period, as measured by an intrauterine pressure catheter). The diagnosis of active phase arrest was made by the managing physician at the time of delivery according to these criteria. Management decisions were under weekly morbidity and mortality peer review for quality assurance according to institutional standards of care. To evaluate management strategies at our institution, we have reviewed the charts of 191 women with a diagnosis of active phase arrest and can state that 48% were expectantly managed beyond 2 hours of APA, 26% beyond 4 hours of APA, and 26% beyond 6 hours of APA.

We extracted all data from a large electronic database containing information regarding prenatal records, labor management, and perinatal outcomes that is prospectively collected, coded and maintained. All clinical data were recorded at the time of admission and delivery by the managing physicians and midwives. Trained data abstractors also perform daily chart review to ensure accurate and complete information reporting.

All data were analyzed using STATA 9.0 (StataCorp, College Station, TX, USA). Univariable analyses using t-tests and chi-square statistics were performed to compare maternal demographic variables as well as vaginal delivery rates across continuous and dichotomous predictors, respectively. A statistical significance level of $p < 0.05$ was used. The frequencies of adverse maternal outcomes and neonatal outcomes were compared by mode of delivery using Fisher's exact and chi-squared tests for dichotomous variables. Next, multivariable logistic regression models were constructed to control for potential confounders including maternal age, parity, maternal race/ethnicity, maternal prepregnancy BMI, prior cesarean delivery, and delivery year. Each model evaluated the risk of adverse outcome associated with cesarean delivery.

Demographic data for women with and without APA were evaluated using basic univariable comparisons, chi-square tests for dichotomous variables and Student's t-tests for continuous variables. The rates of adverse maternal and neonatal outcomes were compared using chi-squared tests as well as by constructing relative risks and associated 95% confidence intervals (CI) associated with the diagnosis of APA for each outcome of interest.

In order to control for the effects of several confounders, we constructed multivariable logistic regression models to estimate the effect of the diagnosis of APA on each of the outcomes of interest. In all cases, covariates in the model included maternal age, parity, race/ethnicity, body mass index (BMI), Medicaid insurance status, history of prior cesarean delivery, induction of labor, epidural use, and delivery year. A single model was constructed for each outcome of interest, each evaluating the effect (adjusted odds ratio, and 95% CI) associated with a diagnosis of active phase arrest. We were not able to construct models in the instances where there were no cases of an outcome in the APA group. Model goodness-of-fit was examined using the Hosmer-Lemeshow test.

Results

Women with active phase arrest: vaginal delivery versus cesarean delivery

We identified 1,014 women with active phase arrest: 33% (335) went on to deliver vaginally and 28% (95) of these women underwent an operative vaginal delivery. Parity, maternal age, and ethnicity did not differ between women who delivered vaginally and those who had cesarean delivery. Compared to women who had cesarean delivery, women who delivered vaginally had a lower BMI (mean BMI 23.4 vs. 25.3 kg/m², $p < 0.001$), and delivered slightly

smaller infants (mean birth weight 3,533 grams ($\pm$ 658) vs. 3,700 grams ($\pm$ 493), $p < 0.001$; Table 1).

Among women with active phase arrest, the univariable analysis revealed an increased rate of all adverse maternal outcomes examined in women who had a cesarean delivery (Table 2). These included chorioamnionitis, endomyometritis, postpartum hemorrhage, severe postpartum hemorrhage, and maternal blood transfusion. However, there were no differences in the rates of adverse neonatal outcomes between women who delivered vaginally and those who had a cesarean delivery.

When the frequencies of adverse outcomes were compared using a multivariable logistic regression model to control for potential confounders, we found that cesarean delivery was associated with an increased risk of chorioamnionitis (aOR 3.37, 95% CI 2.21–5.15), endomyometritis (aOR 48.41, 95% CI 6.61–354), postpartum hemorrhage (aOR 5.18, 95% CI 3.42–7.85), and severe postpartum hemorrhage (aOR 14.97, 95% CI 1.77–126). Adverse neonatal outcomes, however, were not associated with cesarean delivery (Table 3).

Women with Vaginal Delivery: Active Phase Arrest vs. No Active Phase Arrest

This cohort consisted of 12,901 women with a term vaginal delivery, 355 (2.6%) women with APA, and 12,566 without labor dystocia. Demographic and obstetric characteristics were compared between these two groups (Table 4). There were more nulliparous women (74%) who delivered vaginally with a diagnosis of APA compared to women delivered vaginally without APA (53%, $p < 0.001$). Compared to women without APA, more women with APA were more than 35 years at time of delivery (21% vs. 17%, $p = 0.05$), and delivered at ≥ 41 weeks gestation (28% vs. 20%, $p < 0.001$). Fewer women in the APA group had induction of labor (10% vs. 18%, $p < 0.001$), but there was a greater usage of epidural analgesia among women with APA (84% vs. 55%, $p < 0.001$).

The rates of several maternal and neonatal adverse outcomes associated with a diagnosis of APA were compared between the study groups (Table 5). Among women with active phase arrest, there was an increased rate of operative vaginal delivery (28% vs. 17%, $p < 0.001$), as well as increased rates of several adverse maternal outcomes, including, chorioamnionitis (18% vs. 8%, $p, 0.001$), 3rd or 4th degree perineal lacerations (16% vs. 9%, $p, 0.001$), and postpartum hemorrhage (26% vs. 17%, $p < 0.001$) compared to other women having a vaginal delivery without APA. The rates of endomyometritis and blood transfusion were not statistically different between the two groups. Examination of neonatal outcomes revealed increased rates of shoulder dystocia (4% vs. 2%, $p < 0.01$) and 5 minute Apgar < 7 (5% vs. 2%, $p < 0.001$) among women with APA compared to those without (Table 5). The rates of other adverse neonatal outcomes and APA were similar, including sepsis, NICU admission, clavicular fracture, Erb's palsy, and acidemia.

In order to evaluate the effect of active phase arrest on adverse maternal and neonatal outcomes while controlling for potential confounders, we constructed several multivariable logistic regression models (Table 6). The models were tested against the “true” model using the Hosmer-Lemeshow test for goodness-of-fit, which showed no difference ($p > 0.05$). When controlling for potential confounders, women with APA had significantly increased odds of chorioamnionitis (aOR 2.70, 95% CI [1.22–2.36]) and shoulder dystocia (aOR 2.37, [1.33–4.25]). Unlike the univariable models, the odds of operative vaginal delivery did not differ significantly between the groups (aOR 1.00, [0.73–1.36]) nor did the odds of post-partum hemorrhage (aOR 1.35, [0.99–1.83]) or severe perineal lacerations (aOR 0.92, [0.63–1.36]). Finally, after controlling for confounders, infants born to mothers with active phase arrest did not have statistically significantly increased odds of 5 minute Apgar scores < 7 (aOR 1.75, [0.85–3.61]).

Discussion

To systematically evaluate the rates of adverse perinatal outcomes among women with active phase arrest, we made two comparisons. First, we only looked at women with active phase arrest, and compared the outcomes by mode of delivery: vaginal delivery to cesarean delivery. In women with active phase arrest, cesarean delivery was associated with an increased risk of chorioamnionitis, endomyometritis, and postpartum hemorrhage. However, cesarean delivery was not associated with adverse neonatal outcomes in women with active phase arrest. These findings suggest that efforts to achieve vaginal delivery in the setting of active phase arrest may reduce the maternal risks associated with cesarean delivery without additional risk to the neonate.

To get a sense of the number needed to treat to avoid postpartum hemorrhage and blood transfusion, using the raw numbers found in our analysis, we estimate that only 3 women would need to achieve vaginal delivery to prevent one postpartum hemorrhage and 33 women would need to achieve vaginal delivery to prevent one maternal blood transfusion. The number of women needed to be managed expectantly to achieve vaginal delivery and prevent these complications would vary depending on the a priori chance of achieving vaginal delivery. From our work and prior studies, this proportion appears to range from 33% to 60%. Considering these values, the number needed to manage expectantly to prevent postpartum hemorrhage would range from 5 to 9 and to prevent a maternal blood transfusion would range from approximately 50 to 100. Thus, determining which women are likely to achieve vaginal delivery in this setting is an important next step in this area of research.

In addition, our study illustrates several important differences in the perinatal outcomes of women with and without active phase arrest who experienced vaginal deliveries. While many of the outcomes we examined did not differ between the two groups, we did observe a positive association between the diagnosis of APA and an increased risk of chorioamnionitis and shoulder dystocia. Our data also suggest an association between post partum hemorrhage and APA. Of note, when we examined the more serious sequelae associated with these three outcomes, including neonatal sepsis, Erb's palsy, and maternal blood transfusion, we did not find an increased risk in the setting of APA.

While we did not have information regarding the timing of the diagnosis of chorioamnionitis relative to that of APA, it could be that chorioamnionitis may be an effect of APA. However, we think it more likely that chorioamnionitis leads to dysfunctional uterine contractions and is a precursor to APA. In turn, it may be that the increased chorioamnionitis may lead to greater rates of postpartum hemorrhage; thus, intervening with a cesarean delivery appears to be unlikely to be protective against either of these outcomes. However, we also found a two-fold increase in shoulder dystocia in women who experienced APA as compared to other women with vaginal deliveries. This seems consistent with the biology and anatomy of labor, that a tighter cephalo-pelvic relationship may both prolong the length of labor and increase the risk for shoulder dystocia. In contrast, it is also possible that there is diagnostic bias such that clinicians are more likely to diagnose a shoulder dystocia in a woman with APA. Interestingly, we note that no Erb's palsies occurred in the women with APA, so it is unclear whether laboring in the setting of a diagnosis of APA increases the actual neonatal morbidity from shoulder dystocia.

As noted above, we did not observe an increased risk of severe sequelae associated with chorioamnionitis and postpartum hemorrhage, namely, neonatal sepsis and maternal blood transfusion. However, this observed absence of association may be attributed to the rare nature of these outcomes such that the possibility of Type II error exists. For example, for neonatal

sepsis, we only had 15% power to find a 50% difference between the two groups, and for transfusion, 20% power to find a 50% difference.

There are several other important limitations to this study. First, as an observational study, our results may be prone to confounding bias. We attempted to control for this through the use of multivariable logistic regression analyses. In addition, our effect estimates may be confounded by indication. For example, it may be that some women more likely to experience adverse outcomes had cesarean delivery and thus were excluded from our larger study cohort. However, previous studies looking only at women with active phase arrest indicated low and comparable rates of adverse maternal and neonatal outcomes in women delivering vaginally and by cesarean delivery.^{8,9}

Despite these limitations, we provide a useful comparison of outcomes in women who achieved vaginal delivery in the setting of APA that can be used to inform obstetric management and counsel women. We believe that with the lower rate of complications seen in women with APA who deliver vaginally as compared to those who deliver via cesarean, that it is reasonable to utilize oxytocin augmentation and tincture of time to attempt to achieve vaginal delivery in women diagnosed with APA. In this era of falling VBAC rates, the old adage of “once a cesarean, always a cesarean” has become a reality again in the majority of clinical practice settings. Thus, attempting to prevent the first cesarean by expectantly managing a prolonged labor or even with a formal diagnosis of APA seems reasonable. At the very least, we would encourage a multi-center, prospective trial of the management of APA described by Rouse et al to attempt to reduce the cesarean delivery rate in women’s first labors.^{8,9}

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Table 1
Maternal and Neonatal Characteristics: Women with APA

	Vaginal Delivery (n=335)	Cesarean Delivery (n=679)	P-value *
	Percent (n) or mean ($\pm$ SD)	Percent (n) or mean ($\pm$ SD)	
Nulliparous (n=771)	32% (249)	68% (522)	
Multiparous (n=243)	35% (86)	65% (157)	0.37
Age $\geq$ 35 (n=229)	31% (72)	69% (157)	0.56
Race/Ethnicity **			
Caucasian (n=369)	34% (127)	66% (242)	0.26
Black (n=153)	27% (41)	73% (112)	0.11
Hispanic (n=123)	25% (31)	75% (92)	0.07
Asian (n= 286)	35% (100)	65% (186)	0.41
Native American (n=8)	50% (4)	50% (4)	0.28
Medicaid Insurance (n=104)	20% (21)	80% (83)	0.003
BMI (kg/m ²)	23.4 ($\pm$ 5)	25.3 ($\pm$ 6)	< 0.001
Received pitocin (n=859)	32% (272)	68% (587)	0.03
Birthweight (grams)	3533 ($\pm$ 658)	3700 ($\pm$ 493)	< 0.001

* Represents test of significance between two groups from two-tailed t-test for continuous outcomes and chi-squared test for dichotomous outcomes.

** Ethnicity data was not available for all women in our cohort.

Table 2
Perinatal Outcome Rates by Mode of Delivery

	Vaginal delivery (n= 335)	Cesarean delivery (n= 679)	p-value [*]
<i>Maternal Outcomes</i>			
Chorioamnionitis	18%	40%	<0.001
Endomyometritis	1%	19%	<0.001
PPH	26%	60%	<0.001
Severe PPH	2%	6%	0.001
Blood transfusion	0%	3%	<0.001
<i>Neonatal Outcomes</i>			
NICU admission	4%	6%	0.13
Neonatal sepsis	0%	<1%	0.55
5 min Apgar < 7	5%	4%	0.41
** Acidemia	<1%	1%	0.45

*
p-value represents Fisher's exact test.

**
Acidemia is a composite outcome of umbilical cord arterial pH <7.0 or umbilical artery base excess ≤ -12 .

Table 3

Multivariable Analysis: Risk of perinatal outcomes associated with cesarean delivery

Outcome	Adjusted Odds Ratio [*]	95% CI	p-value
Chorioamnionitis	3.37	(2.21–5.15)	<0.001
Endomyometritis	48.41	(6.61–354)	<0.001
PPH	5.18	(3.42–7.85)	<0.001
Severe PPH	14.97	(1.77–126)	0.02
NICU admission	2.57	(0.52–12.7)	0.25
5 min Apgar < 7	1.32	(0.45–3.84)	0.61
Acidemia	2.07	(0.16–27.6)	0.58

* Models controlling for maternal age, parity, maternal race/ethnicity, maternal BMI, prior cesarean delivery, and delivery year

Table 4
Maternal Demographic and Obstetric Characteristics: Women with Vaginal Delivery

	VD with APA (n=335) %(n) or Mean($\pm$ SD)	VD without APA (n=12,566) %(n) or Mean($\pm$ SD)	* P-value
Nulliparous	74 % (249)	53 % (6642)	< 0.001
Multiparous, prior cesarean delivery	24 % (21)	11 % (666)	< 0.001
Maternal Age > 35	21 % (72)	17 % (2179)	0.05
Gestational Age $\geq$ 41 weeks	28 % (94)	20 % (2549)	< 0.001
BMI (kg/m ²)	23.39 ($\pm$ 5.18)	23.30 ($\pm$ 4.82)	0.80
<i>Ethnicity</i> **			
Caucasian	42 % (127)	49 % (4657)	0.48
African American	14 % (41)	17 % (1940)	0.15
Hispanic	10 % (31)	13 % (1464)	0.23
Asian	30 % (100)	28 % (3525)	0.47
Native American	1 % (4)	1 % (72)	0.13
Induction of Labor	10 % (33)	18 % (2212)	< 0.001
Epidural Analgesia	84 % (280)	55 % (6894)	< 0.001
Birthweight > 4000 grams	11 % (37)	10 % (1245)	0.50
OP position at delivery	4 % (14)	5 % (663)	0.03

* P-value represents Chi-squared test for dichotomous variables and t-test for continuous variables

** Ethnicity data was not available for all women in our cohort.

Table 5
Adverse Outcomes by Group

	Outcome Rate in Active Phase Arrest (n=335) % (n)	Outcome Rate in Other Vaginal Deliveries (n=12,566) % (n)	Relative Risk (95%CI)	* P-value
Maternal outcomes				
Operative vaginal delivery	28% (95)	17% (2140)	1.67 (1.40–1.98)	< 0.001
Chorioamnionitis	18% (61)	8% (957)	2.40 (1.89–3.02)	< 0.001
3rd/4th° perineal laceration	16% (52)	9% (1120)	1.74 (1.35–2.25)	< 0.001
Endomyometritis	1% (3)	1% (116)	0.97 (0.31–3.04)	0.96
Post-partum hemorrhage	26% (87)	17% (2121)	1.51 (1.26–1.82)	< 0.001
Blood Transfusion	0% (0)	1% (60)	** 0.62 (0.09–4.48)	0.63
Neonatal Outcomes				
Sepsis	0% (0)	< 1% (18)	** 2.08 (0.28–15.52)	0.47
NICU admission	4% (12)	4% (469)	0.96 (0.55–1.68)	0.89
Shoulder dystocia	4% (14)	2% (250)	2.10 (1.24–3.56)	< 0.01
Clavicular Fracture	< 1% (1)	< 1% (52)	0.72 (0.10–5.20)	0.74
Erb's palsy	0% (0)	< 1% (29)	** 1.29 (0.18–9.44)	0.80
Cephalohematoma	5% (16)	4% (450)	1.33 (0.82–2.17)	0.25
5 minute Apgar < 7	5% (17)	2% (267)	2.39 (1.48–3.85)	< 0.001
Acidemia	< 1% (1)	2% (129)	0.27 (0.04–1.90)	0.15

* P-value represents Chi² test.

** Relative risks estimated using hypothetical subject in APA group with average value of covariates, since there were no cases of the outcome in the APA group.

Table 6
Multivariable Analysis: Risk of perinatal outcomes associated with active phase arrest

Outcome	Unadjusted Odds Ratio	95% CI	* Adjusted Odds Ratio	95% CI	P-Value
Operative VD	1.93	1.51–2.46	1.00	0.73–1.36	0.98
Chorioamnionitis	2.70	2.03–3.59	1.78	1.22–2.36	<0.01
PPH	1.70	1.32–2.18	1.35	0.99–1.83	0.06
Peri 3 or 4	1.88	1.39–2.54	0.92	0.63–1.36	0.69
Endomyometritis	0.97	0.31–3.07	0.29	0.04–2.14	0.22
Shoulder dystocia	2.15	1.24–3.72	2.37	1.33–4.25	<0.01
5 min Apgar >7	2.46	1.49–4.07	1.75	0.85–3.61	0.13

* Multivariate logistic regression controlling for maternal age, parity, insurance status, race/ethnicity, BMI, history of prior CD, IOL, epidural use, and delivery year.