Relationship between Fetal Station and Successful Vaginal Delivery in Nulliparous Women

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Abstract

Objective—To study the relationship between fetal station and successful vaginal delivery in nulliparous women.

Study Design—This was a secondary analysis from a previously reported trial of pulse oximetry. Vaginal delivery rates were evaluated and compared with respect to the fetal station. Spontaneous labor and induction of labor groups were evaluated separately. Multivariable logistic regression analysis was performed to adjust for confounding factors.

Results—Successful vaginal delivery was more frequent with an engaged vertex for spontaneous labor (86.2% versus 78.6%; $p = 0.01$) and induced labor (87.7% versus 66.1%; $p < 0.01$). After adjustment, engaged fetal vertex was not associated with vaginal delivery for spontaneous labor (odds ratio [OR] 1.5; 95% confidence interval [CI] 0.95 to 2.3; $p = 0.08$) or for women with induced labor (OR 2.2; 95% CI 0.96 to 5.1; $p = 0.06$).

Conclusion—Among nulliparous women enrolled in the FOX randomized trial in spontaneous labor or for labor induction, an engaged fetal vertex does not affect their vaginal delivery rate.

Keywords

labor; fetal station; vaginal delivery

In early studies by Friedman and Sachtleben, a high fetal station on presentation was associated with a dysfunctional labor pattern.[1–4] Subsequent studies examined the relationship between fetal station and cesarean delivery and demonstrated that an unengaged vertex at the time of active labor is associated with a significantly increased chance of cesarean delivery.[4–7] Yet, the relevance of these findings to the present day is uncertain as obstetric practice has been characterized by a decreased frequency of operative vaginal delivery and an increased frequency of cesarean delivery.[8] The demographic characteristics of reproductive-aged women in the United States have also changed such that the pregnant women are more likely to be older and have a greater body mass index (BMI).[9,10] Both of these factors have been linked to higher rates of cesarean delivery.[11–13]

Thus, in the context of the present obstetric population and the approach to medical care, the relationship between station at admission for labor and vaginal delivery remains uncertain. This secondary analysis of detailed labor data from the modern era was performed to estimate the association between fetal station at admission and subsequent vaginal delivery.

Methods

We conducted a secondary analysis of data derived from a randomized clinical trial of fetal pulse oximetry, in which the 14 clinical centers of Eunice Kennedy Shriver National Institute of Child Health and Human Development Maternal Fetal Medicine Units Network[14] participated. Nulliparous women 36 weeks' gestation with a singleton fetus who presented to labor and delivery between May 2002 and February 2005 were offered enrollment in the study. Those who consented were randomized when their cervical dilation was between 2 and 6 cm and the fetal vertex had reached −1 station. Randomization was performed by a research nurse through an encrypted program in a laptop computer. Women were excluded if they had a temperature > 38°C, HIV, hepatitis, diabetes mellitus, or maternal cardiac or renal disease. Women with hypertensive disorders were not excluded and were eligible for participation in the study and this analysis. The study was approved by the institutional review board at each center, and written informed consent was obtained from all study participants prior to enrollment.

Trained research nurses who were present and managing the pulse oximeter collected the labor and delivery data. For women who presented in spontaneous labor, fetal station was defined as that determined by the examination upon admission to labor and delivery. For women who presented for an induction of labor, fetal station was defined as that determined by the first examination at the time of induction. Women were excluded from analysis if no examination was recorded within 30 minutes of admission for spontaneous labor or at the initiation of their labor induction. Depending on the clinical center, fetal station was recorded based either on the −5 to +5 scale or the −3 to +3 scale. Acknowledging the

recommendation of the American Congress of Obstetricians and Gynecologists for using −5 to +5 scale, simple clinical conversion was only possible from the −5 to +5 scale to the −3 to +3 scale. As a result, −5 to +5 station data were converted to the −3 to +3 scale for the purposes of this analysis (►Table 1). This decision was made prior to beginning the analysis.

Fetal station was analyzed both as an ordinal and dichotomous variable. Because the number of cases with station at +1 and +2 was small, these two groups were combined for analyses utilizing station as an ordinal variable. The association of fetal station with vaginal delivery was evaluated using the Mantel-Haenszel chi-square test for trend, and with time to delivery using the Jonckheere-Terpstra test for trend. For the dichotomous analyses, station was categorized according to whether the fetal vertex was engaged, defined as station 0 or below. The association of dichotomous fetal station with vaginal delivery was evaluated using the chi-square test and with time to delivery using the Wilcoxon rank sum test.

Women who presented in spontaneous labor and women who presented for an induction of labor were analyzed separately. Women in spontaneous labor were further divided according to whether their cervical dilation was 4 cm or <4 cm at admission. The interaction effect of cervical dilation at admission and fetal station as an ordinal variable on vaginal delivery was assessed with logistic regression and on time to delivery with linear regression. The same interaction effect with fetal station as a dichotomous variable on vaginal delivery was assessed with the Breslow-Day test for homogeneity of the odds ratios (ORs) and on time to delivery with the Van Elteren test, a nonparametric test for stratified continuous data.[15] The association between fetal station and vaginal delivery was additionally analyzed using multivariable logistic regression models that controlled for the following variables chosen by the authors, a priori: maternal prepregnancy BMI, age, and race/ethnicity, as well as birth weight, presence of membrane rupture and cervical dilation at admission, and trial intervention group. Analysis was performed to test the presence of significant multicollinearity between covariates in the regression. Multivariable analyses of the data from the induced labor group also controlled for the occurrence of an elective induction. Assuming 67% of women would achieve a vaginal delivery and 4% would be admitted with an engaged fetal vertex, we are able to detect an OR of 2.0 or more with $\alpha = 0.05$, statistical power of 80%, nine covariates, and the available number of women in the induced labor group. With similar assumptions, an OR of 1.7 or greater is detectable in the spontaneous labor group. All reported p values are two-sided, and $p < 0.05$ was considered significant. No adjustments were made for multiple comparisons. SAS software (SAS Institute, Inc., Cary, NC) was used for analysis.

Results

Of the 5341 nulliparous women randomized in the fetal pulse oximetry trial, a cervical examination that included fetal station on admission to labor and delivery and met the inclusion criteria with regard to timing was available for 2177/3123 (69.7%) of the women admitted in spontaneous labor and 1841/2218 (83.0%) of the women admitted for induction of labor. The majority of the population eligible for this analysis was Caucasian and

presented with a cervical dilation <4 cm, and 19.6% had a BMI greater than 30 kg/m^2. Demographic and obstetric characteristics at admission are presented in ►Table 2.

In the univariable analysis of women who presented in spontaneous labor, lower station of the fetal vertex at presentation was associated with a significantly higher likelihood of vaginal delivery. This relationship was present when fetal station was evaluated either as an ordinal or dichotomous variable (►Tables 3 and 4). The magnitude of this relationship, for women in spontaneous labor, did not differ on the basis of cervical dilation at initial exam (p = 0.75, interaction term for ordinal analysis; p = 0.66, interaction term for categorical analysis). A similar association between station and vaginal delivery was seen for women undergoing labor induction (►Tables 3 and 4). In addition, among those who underwent cesarean, there were no differences between those with an engaged and those without an engaged vertex in the proportion with arrest disorders (spontaneous labor: 65.4 versus 65.7%, p = 0.98; labor induction: 57.1% versus 78.0%, p = 0.19).

Prepregnancy BMI, maternal age, race/ethnicity, cervical dilation and status of membranes at admission, and birth weight were included in the multivariable logistic regression analysis that was performed to adjust for confounding factors. For women in spontaneous labor, an engaged station was no longer significantly associated with more frequent vaginal delivery after this adjustment (adjusted OR 1.5; 95% confidence interval 0.95 to 2.3; p = 0.08). For women undergoing labor induction, the multivariable regression model also included a variable to represent elective induction and revealed the lack of a significant association between an engaged fetal station and vaginal delivery after controlling for other factors (adjusted OR 2.2; 95% confidence interval 0.96 to 5.1; p = 0.06). In neither the spontaneous labor nor the labor induction cohort was there any interaction between use of fetal pulse oximetry and engaged station (p = 0.73 and 0.13, respectively).

Analysis of time from admission to delivery among women who presented in spontaneous labor revealed a lower fetal station at presentation to be associated with a significant decrease in the duration of labor, although only when station was represented as a dichotomous variable (►Tables 5 and 6). The magnitude of this relationship differed on the basis of cervical dilation at initial exam (p = 0.01, interaction term). Among women presenting with a cervix at <4 cm dilation, an engaged fetal station was associated with a shorter duration of labor (median 10.0 versus 11.2 hours, $p < 0.01$), but not among those with a cervix at 4 cm (p = 0.48). In women who underwent induction of labor, a lower fetal station also was associated with a significantly decreased length of labor, regardless of whether station was analyzed as an ordinal or a dichotomous variable (►Tables 5 and 6).

Discussion

In this analysis of data from the Maternal Fetal Medicine Units Network fetal pulse oximetry trial, engagement of the fetal vertex was not associated with a greater probability of successful vaginal delivery in nulliparous women who presented at 36 weeks' gestation. These results differ from the results of previous studies. For example, in a study of Nigerian women with active phase labor arrest, Oboro et al reported that an unengaged fetal vertex at admission was associated with a significantly increased risk for cesarean delivery.[5] In a

retrospective study, Roshanfekr et al also found a significant increase in cesarean delivery among nulliparous women who presented with an unengaged fetal vertex, even after controlling for confounding factors.[6] Nevertheless, it should be noted that the large majority (86%) of women in this study who presented with an unengaged fetal vertex had a successful vaginal delivery. The association between engagement of the vertex at admission and vaginal delivery also was explored by Peaceman et al in their trial evaluating active management of labor.[16] In their trial, 700 laboring nulliparous women at term were randomized to traditional versus active management of labor. Multivariable analysis demonstrated a significant increase in cesarean delivery in both actively managed labor (OR 2.7, 95% CI 1.2 to 6.0) and traditionally managed labor (OR 3.2, 95% CI 1.6 to 6.3) among women who presented with a fetal station higher than −1.[16]

The differences in the results of the present analysis from previous results may be due to differences in the demographic characteristics of the patients as well as changes in labor management. One could postulate that increasing maternal age and obesity in pregnant women in concert with a decreasing frequency of operative vaginal deliveries may have altered the association between lack of engagement at admission and subsequent vaginal delivery. Alternatively, the difference in results may reflect the particular inclusion criteria for the fetal pulse oximetry trial and this secondary analysis. Women could not be randomized, or correspondingly included in this secondary analysis, unless the fetal station reached at least −1. This may imply that higher station at admission is not a risk factor for cesarean birth as long as progress to at least −1 station is made.

The strengths of this secondary analysis include that it has a large sample size and patients from 14 different centers across the United States, which enhance the power to detect a difference as well as external validity. Additionally, ascertainment bias is reduced due to the fact that data were prospectively collected by trained research nurses.

One of the limitations of this study is that the only patients who were included were those who were eligible for the original fetal pulse oximetry trial. Women who presented in active labor and rapidly progressed to delivery may have missed the window for randomization and thus were not included in that trial or this secondary analysis. Also, 94% of the study population presented with an unengaged vertex, a frequency that is somewhat higher than the range of 70 to 80% range noted in other studies.[5,6] In addition, because the demographic characteristics of our cohort are different than certain segments of the U.S. pregnant population, the ability to generalize our findings to all nulliparous women is limited. These circumstances raise the possibility that our findings are not generalizable to the general population. Thirty percent of the cohort that presented with spontaneous labor and 17% of the cohort that presented for an induction of labor did not have fetal station recorded and were excluded from the analysis. If these women had more complete cervical examinations recorded and could be included in this analysis, our findings could potentially be altered. Last, although the multivariable results did not reach the threshold for statistical significance, the confidence intervals crossed unity by only a small degree, and a larger population may have been able to detect a statistically significant association.

In summary, this analysis demonstrates that even though many nulliparous women present in labor or for induction with an unengaged vertex, the majority will nevertheless have a vaginal delivery. Moreover, after controlling for multiple potentially confounding factors, station at admission is not significantly associated with the chance of cesarean delivery. Correspondingly, a high or unengaged fetal station on admission does not appear to be a useful predictor of cesarean delivery and should not be used to deter an adequate trial of labor.

Acknowledgments

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Table 1

Conversion of the −5 to +5 Scale to −3 to +3 Scale

−5 to +5	−3 to +3
−5	−3
−4, −3	−2
−2, −1	−1
0	0
+1, +2	+1
+3, +4	+2
+5	+3

Table 2

Maternal Demographics and Obstetric Characteristics Stratified by Type of Labor and Documentation of Station on Admission

	Spontaneous Labor (*n* = 2177)	Spontaneous Labor without Recorded Station (*n* = 946)	*P*	Induced Labor (*n* = 1841)	Induced Labor Without Recorded Station (*n* = 377)	*P*
Fetal station						
Ballotable	59 (2.7)			125 (6.8)		
− 3	414 (19.0)			464 (25.2)		
− 2	573 (26.3)			619 (33.6)		
− 1	942 (43.3)			576 (31.3)		
0	175 (8.0)			55 (3.0)		
+ 1	12 (0.6)			2 (0.1)		
+ 2	2 (0.1)			0		
Engaged	189 (8.7)			57 (3.1)		
Cervical dilation (cm)	3.0 ± 1.2			1.7 ± 1.1		
Active labor	810 (37.2)			110 (6.0)		
Membranes ruptured at or before admission	716 (33.0)	352 (37.4)	0.02	375 (20.4)	32 (8.5)	<0.001
Elective induction				374 (20.3)	42 (11.1)	<0.001
Pharmaceutical ripening agent				492 (26.7)	122 (32.4)	0.03
Gestational age (wk)	39.7 ± 1.2	39.7 ± 1.3	0.32	40.0 ± 1.4	40.1 ± 1.4	0.03
Race			<0.001			<0.001
African-American	804 (36.9)	207 (21.9)		566 (30.7)	78 (20.7)	
Caucasian	1035 (47.5)	412 (43.6)		1058 (57.5)	257 (68.2)	
Other	338 (15.5)	327 (34.6)		217 (11.8)	42 (11.1)	
Hispanic/Latino ethnicity	498 (22.9)	418 (44.2)	<0.001	323 (17.5)	70 (18.6)	0.64
Married	966 (44.4)	440 (46.5)	0.27	962 (52.3)	231 (61.3)	0.001
Maternal age (y)	22.9 ± 5.4	23.9 ± 5.9	<0.001	23.6 ± 5.2	25.4 ± 6.2	<0.001
Maternal age ≥ 35 y	92 (4.2)	52 (5.5)	0.12	69 (3.8)	37 (9.8)	<0.001
Prepregnancy BMI (kg/m^2)	24.9 ± 5.8	25.1 ± 5.8	0.29	26.4 ± 6.5	26.0 ± 6.4	0.27
Obese (BMI ≥ 30 kg/m^2)	329 (15.6)	141 (15.6)	0.97	433 (24.2)	82 (22.3)	0.43
Hypertension			0.49			0.97
None	2051 (94.2)	899 (95.0)		1434 (77.9)	298 (79.1)	
Gestational	59 (2.7)	23 (2.4)		184 (10.0)	36 (9.6)	
Mild preeclampsia	60 (2.8)	19 (2.0)		198 (10.8)	38 (10.1)	
Severe preeclampsia	7 (0.3)	5 (0.5)		25 (1.4)	5.0 (1.3)	
Birth weight (g)	3334 ± 436	3361 ± 441	0.15	3379 ± 493	3461 ± 502	<0.001
Birth weight ≥ 4000 g	150 (6.9)	76 (8.0)	0.26	182 (9.9)	50 (13.3)	0.05

	Spontaneous Labor (n = 2177)	Spontaneous Labor without Recorded Station (n = 946)	P	Induced Labor (n = 1841)	Induced Labor Without Recorded Station (n = 377)	P
"Open" oximetry group	1057 (48.6)	496 (52.4)	0.05	901 (48.9)	175 (46.4)	0.37

Presented as n (%) or as mean ± standard deviation. BMI, body mass index.

Table 3

Relationship between Fetal Station Represented as an Ordinal Variable and Vaginal Delivery

	Ballotable	**−3**	**−2**	**−1**	**0**	**+1/+**	**P**^{a}
Spontaneous labor	41/59 (69.5)	340/414 (82.1)	432/573 (75.4)	750/942 (79.6)	152/175 (86.9)	11/14 (78.6)	0.04
Induction of labor	80/125 (64.0)	289/464 (62.3)	382/619 (61.7)	429/576 (74.5)	49/55 (89.1)	1/2 (50.0)	<0.01

Data are *n* (%) unless otherwise specified.

^{a}Mantel-Haenszel chi-square test for trend.

Table 4

Relationship between Fetal Station Represented as a Dichotomous Variable and Vaginal Delivery

	Engaged	**Not Engaged**	*P*	**Odds Ratio (95% CI)**
Spontaneous labor	163/189 (86.2)	1563/1988 (78.6)	0.01	1.7 (1.1,2.6)
Induction of labor	50/57 (87.7)	1180/1784 (66.1)	< 0.001	3.7 (1.6,8.1)

Data are *n* (%) unless otherwise specified. CI, confidence interval.

Table 5

Time from Admission (h) to Delivery Stratified by Fetal Station

	Ballotable	−3	−2	−1	0	+1/ + 2	P^a
Spontaneous labor	9.4 (6.9, 11.4); n = 59	9.8 (7.0, 13.8); n = 414	10.4 (7.7, 14.0); n = 573	10.4 (7.7, 13.5); n = 942	8.6 (6.6, 11.6); n = 175	9.5 (6.9, 11.2); n = 14	0.27
Induction of labor	17.2 (13.3,24.0); n = 125	17.1 (12.3,22.7); n = 464	15.9 (11.7,21.0); n = 619	11.1 (8.3, 15.2); n = 576	8.8 (7.0, 12.1); n = 55	12.8 (10.0, 15.6); n = 2	<0.001

Data are median (interquartile range) unless otherwise specified. The time from admission to delivery for women who presented in spontaneous labor ranges from 2.1 to 37.8 h and for women who presented for an induction of labor ranges from 2.4 to 76.1 h.

[a] Jonckheere-Terpstra test for trend.

Table 6

Time from Admission to Delivery (h) Stratified by Engagement of the Fetal Vertex[a]

	Engaged	**Unengaged**	**P**
Spontaneous labor	8.7 (6.6, 11.6); $n = 189$	10.3 (7.6, 13.7); $n = 1988$	<0.001
Cervix < 4 cm	10.0 (7.4, 12.6); $n = 80$	11.2 (8.5, 14.8); $n = 1287$	<0.01
Cervix 4 cm	8.5 (6.4, 10.5); $n = 109$	8.5 (6.0, 11.2); $n = 701$	0.48
Induction of labor	8.9 (7.1, 12.1); $n = 57$	14.6 (10.2, 20.5); $n = 1784$	<0.001

[a]Data are median (interquartile range) unless otherwise specified. The time from admission to delivery for women who presented in spontaneous labor ranges from 2.2 to 34.4 h in those with an engaged fetal vertex and 2.1 to 37.8 h in those with an unengaged fetal vertex. The same time for women who presented for an induction of labor ranges from 2.1 to 23.3 h in those with an engaged fetal vertex and 2.4 to 76.1 h in those with an unengaged fetal vertex.