Duration of Labor Induction in Nulliparous Women at Term: How Long Is Long Enough?

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ABSTRACT

We evaluated the relationship between duration of labor induction and successful vaginal delivery (VD) in nulliparous women at term. Nulliparous women with singleton pregnancies ≥ 37 weeks who underwent labor induction at a single institution were studied. Exclusion criteria were nonvertex presentation, stillbirth, fetal chromosomal/structural abnormalities, spontaneous labor, and spontaneous rupture of membranes. VD rates and maternal/neonatal outcomes were evaluated and compared with respect to the duration from induction to delivery. Over the 1-year study period, 340 women met all criteria. Seventy-five percent achieved VD ($n = 255$), 40.6% of whom had rate of cervical dilation in active labor < 1.0 cm/hour. Women requiring cesarean delivery were more likely to have fetal acidemia, admission to the neonatal intensive care unit, chorioamnionitis, and endometritis. There was no association with prolonged induction to delivery intervals and adverse maternal/neonatal outcomes. In our population, only 5.7% of nulliparous women undergoing labor induction at term remain undelivered at 48 hours. Of women achieving VD, $> 40\%$ had rate of cervical dilation in active labor < 1.0 cm/hour.

KEYWORDS: Labor induction, nulliparous women, labor, induction

Management of nulliparous women undergoing labor induction is a routine, but often potentially complicated process for the practicing obstetrician. Nulliparous women are more likely to have an "unfavorable cervix," and thus their labor may be significantly prolonged and associated with an overall lower rate of successful vaginal delivery (VD).[1–4] In many practice settings, knowledge of these medical facts may lead to a lower threshold for cesarean delivery (CD). This may also be in part due to physician factors[5,6] (medicolegal concerns and convenience issues) combined with patient factors[7] (greater acceptance for CD as well as high expectation for "perfect neonatal outcomes"). Given the decreasing rate of vaginal birth after cesarean delivery (VBAC), delivery mode choices for this first delivery may have profound obstetrical consequences for the remainder of a woman's reproductive lifetime.[8,9]

This dilemma led us to consider whether there was a time-course threshold for our population at which the success rate for continuation of labor induction was so low that it would not justify continuation due to diminishing success rates and increasing complication rates. The objectives of this study were (1) to evaluate the relationship between duration of labor induction and successful VD for nulliparous women with term pregnancies, and (2) to determine whether prolonged labor induction was associated with increased maternal/neonatal short-term adverse outcomes.

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MATERIALS AND METHODS

A computerized perinatal database was used to identify term ($\geq$ 37 weeks) pregnancies delivered by nulliparous women between January 1, 2005, and December 31, 2005, at Hutzel Women's Hospital, Detroit, Michigan. Exclusion criteria were multiple gestations, elective CD, nonvertex presentation, stillbirth, fetal chromosomal/structural abnormalities, spontaneous labor, and spontaneous rupture of membranes. Study personnel reviewed maternal and neonatal charts to obtain pertinent clinical and outcome data. Maternal variables included age, race, gestational age, insurance status, body mass index (BMI), maternal medical disorders (asthma, hypertension, and diabetes), smoking, and substance use (tobacco, cocaine, alcohol, narcotics). Intrapartum factors analyzed included cervical ripening method and modified Bishop score (modified Bishop score total = 9 points [dilation, station, effacement]). Other intrapartum data included labor induction indication (maternal [preeclampsia, maternal medical disorder], fetal [intrauterine growth restriction, oligohydramnios, decreased fetal movement, nonreassuring fetal testing], other [elective, advanced gestational age]), oxytocin augmentation, epidural use, chorioamnionitis, duration latent labor, duration active phase, total induction to delivery time, shoulder dystocia, delivery mode, and indication for CD (nonreassuring fetal status, failed induction/labor arrest, other). Latent phase was defined as time first cervical ripening agent was given until time cervical dilation reached 4 cm, and active phase was defined as time from 4 cm until complete cervical dilation. Maternal outcomes reported included endometritis, postpartum hemorrhage (estimated blood loss [EBL] $>$ 500 mL following VD, EBL $>$ 1000 mL following CD), need for transfusion blood products, and wound infection/separation. Neonatal outcomes reported were birthweight (BW), 5-minute Apgar $<$ 7, fetal acidemia (umbilical artery pH $<$ 7.10 mm Hg and base excess $>$ 12 mEq/L), and neonatal intensive care unit (NICU) admission. Umbilical pH $<$ 7.10 was chosen because it represents two standard deviations from the mean.

SPSS statistical software was used (SPSS Inc., Chicago, IL). The rates of maternal and neonatal complications were also determined and compared for induction to delivery time intervals ($<$ 24, 24 to 48, and $>$ 48 hours). One-way analysis of variance, chi-square, and Kruskal-Wallis tests were performed where appropriate to evaluate the relationship between induction to delivery time and maternal and neonatal outcomes. A p value $<$ 0.05 was considered significant for statistical comparisons.

RESULTS

Over the 1-year study period, 1352 nulliparous women had term deliveries that met study criteria (overall CD rate, 21.2%). Of these women, 871 (64.5%) had spontaneous labor, and 141 (10.4%) had spontaneous rupture of membranes; thus 340 (25.1%) women undergoing labor induction remained for analysis. Of the 340 women who had labor induction, 305 reached active phase of labor (n = 35 had CD in latent phase), and 255 women achieved vaginal delivery (75%).

Table 1 describes the clinical characteristics of women undergoing labor induction. The study group represented the delivery population: 85% were African American, 66.6% had governmental insurance, and 66.8% were obese (BMI $>$ 30 kg/m^2). Over half of the women had an "unfavorable" cervix: 52.1% had modified Bishop score $<$ 2 (total, 9 points).

Twenty-five percent (n = 85) of women required CD; of these 41.1% (35 of 85) were still in latent labor. The CD indications for women in latent labor were labor arrest/failed induction for 51% and nonreassuring fetal status for 49%. Women who underwent CD after

Table 1 Patient Characteristics

	All Patients N = 340
Maternal age (y)	22 (14–46)
Maternal age $<$ 18 y	22 (6.5%)
Maternal age $>$ 35 y	14 (4.1%)
Race	
African American	289 (85%)
White	21 (6.2%)
Other	30 (8.8%)
Governmental insurance	225 (66.6%)
BMI (kg/m^2)	33.2 (20.2–69.3)
BMI $>$ 30 (kg/m^2)	227 (66.8%)
BMI $>$ 40 (kg/m^2)	71 (20.9%)
Induction indication	116 (34.1%)
Maternal	135 (39.7%)
Fetal	89 (26.2%)
Other	
Cervical status	
Modified Bishop score 0	97 (29.5%)
Modified Bishop score 1	74 (22.6%)
Modified Bishop score 2	74 (22.6%)
Modified Bishop score 3	43 (13.1%)
Modified Bishop score 4	34 (10.4%)
Modified Bishop score 5	6 (1.8%)
Cervical ripening agents	
''Low-dose'' oxytocin	254 (75%)
Intracervical Foley	87 (26%)
Misoprostol	79 (23%)
Prostaglandin E2	51 (15%)
$MgSO_4$ prophylaxis	79 (23.2%)
Epidural	299 (88%)

Data expressed as n (%), median (range).
Modified Bishop score total = 9.
Cervical examination data available for 328 of 340 patients.
Most patients received multiple cervical ripening agents.
BMI, body mass index.

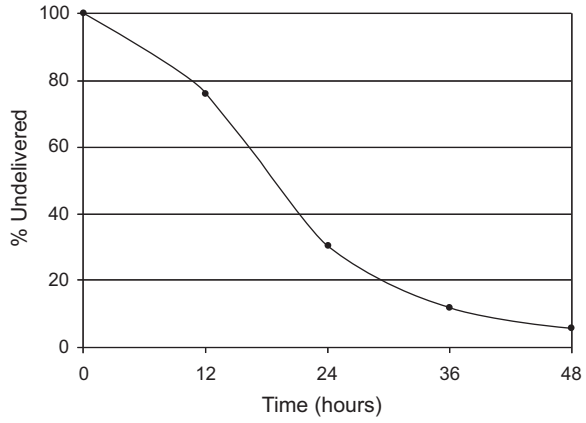

Figure 1 Relationship among the percentage of women undergoing labor induction who remain undelivered over time (0 to 48 hours). The majority of women were delivered within 24 hours (69.3%), and only 5.7% remained undelivered at 48 hours.

reaching active labor (59.9% [50/85]) underwent CD due to labor arrest in 72% cases and nonreassuring fetal status in 28%. The majority of women were delivered within 24 hours (69.3%), and only 5.7% (n = 19) remained undelivered at 48 hours (see Fig. 1).

Table 2 describes selected maternal and neonatal outcomes between women delivered by CD and VD. Overall, rates of both maternal and neonatal morbidities were low. Women with CD were more likely to have chorioamnionitis, endometritis, and longer postpartum stays. Table 3 describes the relationship between selected adverse outcomes (fetal acidemia, NICU admit, endometritis, postpartum hemorrhage) and labor induction to delivery time. There was no relationship between advancing induction to delivery time (< 24 hours, 24 to 48 hours, and > 48 hours) and endometritis ($p = 0.16$), postpartum hemorrhage ($p = 0.17$), fetal acidemia ($p = 0.20$), or NICU admission ($p = 0.56$).

Table 3 Relationship between Induction to Delivery time, Delivery Mode, and Selected Maternal/Neonatal Outcomes

Outcome	Time Induction to Delivery (hr)		
	< 24 N = 231	24–48 N = 84	> 48 N = 19
Fetal acidemia*	6% (9/150)	4.2% (2/48)	12.5% (1/8)
NICU admit	1.3%	1.2%	1%
Postpartum hemorrhage	6%	5%	—
Endometritis	2%	5%	1%

*Data not available for all patients.
Data presented as n (%).
There were no statistical differences between the rate of adverse maternal/neonatal outcomes and time from induction to delivery.
NICU, neonatal intensive care unit.

Three vaginal deliveries were complicated by shoulder dystocia (1.2%) and seven (2.8%) had a severe vaginal laceration (third or fourth degree). Table 4 demonstrates the 50th, 90th, and 95th percentiles for the duration of latent labor and active labor for those women who achieved VD. Of women with VD, 40.6% (n = 89 of 219), had rate of cervical dilation in active labor < 1.0 cm/hour. The time from induction to delivery for those achieving VD was available for 253 women; 73.9% delivered < 24 hours (n = 187), 22.1% delivered between 24 and 48 hours (n = 56), 3.2% delivered between 48 and 72 hours (n = 8), and 0.8% delivered > 72 hours (n = 2).

Table 2 Selected Maternal and Neonatal Outcomes Based on Delivery Mode

	All N = 340	CD N = 85	VD N = 255
Birthweight (g)*	3205.5 (1940–4570)	3253.2 (1975–4530)	3165 (1940–4570)
5-min Apgar < 7†	4 (1.1%)	3 (3.5%)	1 (0.4%)
pH (mm Hg)§	7.22 ± 0.08	7.21 ± 0.10	7.23 ± 0.08
Fetal academia†	13 (6.1%)	7 (10.8%)	6 (4.2%)
NICU admit†	5 (1.5%)	3 (3.5%)	2 (0.8%)
Postpartum hemorrhage†	11 (3.2%)	3 (3.5%)	8 (3.1%)
Chorioamnionitis†#	11 (3.2%)	6 (7%)	5 (2%)
Endometritis†	11 (3.2%)	9 (11%)	2 (1%)
Wound complications	—	—	—
Transfusion†	1 (0.3%)	1 (1.2%)	—
Postpartum days†#	2 (1–10)	3 (2–10)	2 (1–4)

*There were significant differences between CD and VD delivery patients for the following variables: chorioamnionitis $p = 0.03$; endometritis $p < 0.001$; postpartum days $p < 0.0001$.
†N (%).
§Mean ± standard deviation.
#There were significant differences between CD and VD delivery patients for the following variables: chorioamnionitis $p = 0.03$; endometritis $p < 0.001$; postpartum days $p < 0.0001$.
± Median (range).
CD, cesarean delivery; VD, vaginal delivery; NICU, neonatal intensive care unit.

Table 4 Labor Progress Data for Women Who Achieved Vaginal Delivery

	N = 219
Latent phase duration (hr)	
50th percentile	10.8
90th percentile	26.6
95th percentile	33.3
Active phase duration (hr)	
50th percentile	5.6
90th percentile	11.2
95th percentile	13.6
Second-stage labor (min)	
50th percentile	36
90th percentile	125.6
95th percentile	152.4
Active labor rate (cm/hr)	
95th percentile	4.5
90th percentile	3.3
50th percentile	1.1
10th percentile	0.5
5th percentile	0.4

Complete data available for 219 of 255 women who achieved vaginal delivery. Latent phase was defined as time first cervical ripening agent was given until time cervical dilation reached 4 cm. Active phase was defined as time from 4 cm until complete cervical dilation.

DISCUSSION

Our study had several findings that may have important ramifications for clinical practice. The overall CD rate for our population was 25%; and even women with very unfavorable cervix (modified Bishop score zero [29.5% of study population]) achieved VD in 67% of cases. Given the known association between increased risk for CD with labor induction and an "unfavorable cervix," it was somewhat surprising that the CD rate for the study population was not higher. In our population, 94.4% of women were delivered within 48 hours of initiation of induction. From an obstetrical policy perspective, it would not be unreasonable to use this time parameter (48 hours) to guide clinicians and counsel patients on what is an adequate duration to continue attempt labor.

The lack of significant increase in major morbidity even with prolonged induction to delivery time periods is similar to prior studies.[3,10] Using a standardized protocol, Rouse et al also demonstrated minimal overall morbidity with prolonged labor induction duration.[10] In a very different patient population, Simon and Grobman found that women with prolonged latent phase >18 hours had a higher rate of chorioamnionitis and postpartum hemorrhage; however, this did not translate into significant maternal and neonatal morbidity.[3] Despite a very different patient population than Simon and Grobman, we found a similar absence of major morbidities even with prolonged labor. Our study is different from Rouse et al and Simon and Grobman in that we examined the total time from initiation of cervical ripening until delivery, rather than measuring length of latent labor or length of time after membrane rupture. We believe that our study adds to the literature on the subject because it provides an outcome measure that patients and providers can better appreciate: how long induction will last from beginning to end.

Another finding of our study is that women who achieved VD had labor progress quite different compared with prior normative standards. Most practicing obstetricians would not be at all surprised that the combination of an unfavorable cervix, epidural use (88% in our study), and nulliparous status results in a much "slower" but still successful labor process. Use of traditional "Friedman curve" data[11] for this population would seem inappropriate and is supported by the work of several other investigators.[1,3,12–14] Future large observational studies are needed to redefine the normative pattern for labor progress for this study population.

There are some limitations to our study. First, the study was performed at a single institution that is an urban university-based hospital. Thus the characteristics of the study population as well as the practice patterns of physicians may not be applicable to other settings. The retrospective nature of the study cannot exclude potential biases including the lack of standardized management protocol. Because there was not a predefined management protocol, it is possible that some patients may have had a "period of rest" that may have lengthened the duration of labor induction. Because data were not obtained prospectively and without a standardized definition for determining the timing or indication for CD, there is the potential for bias in that some cases of CD may have been done for fetal indications or "labor arrest" (in either latent or active labor) due to physician or patient intolerance to continue with induction. The study population did not include multiparous women or women attempting VBAC and represented a mostly low-risk group. Finally, the sample size limits the ability to draw conclusions related to the relationship between maternal/neonatal adverse outcomes and induction to delivery intervals.

In conclusion, our study provides at least two findings useful to clinicians managing labor induction in nulliparous women: (1) labor progress much slower than traditional standards should be expected, and (2) with appropriate labor management, a reasonably high rate of VD (with a low rate of complications) is possible.

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