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Term induction of labor and risk of cesarean delivery by parity

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Abstract

Objective—To evaluate the risk of cesarean delivery among both nulliparous and multiparous women undergoing a term induction of labor compared to women that present in spontaneous labor at term.

Methods—We performed a retrospective cohort study of term (≥ 37 weeks) singleton pregnancies between 2005 and 2010 comparing women that had an induction to those that presented in spontaneous labor. Multiparity was defined as a prior delivery after 20 weeks' gestation. Chi-square was used to compare categorical variables. Multivariable logistic regression was used to control for confounders. Analyses were stratified by parity.

Results—863 women were included in the analysis. There were 605 inductions (cesarean rate 23%) and 257 spontaneous labor (cesarean rate 7%), OR 3.4, 95% CI [2.1–5.4]. Stratified by parity, nulliparas undergoing induction had an increased cesarean rate compared to spontaneous labor (27% versus 11%, OR 3.13, 95% CI [1.76–5.57]) as did multiparas (13% versus 3%, OR 4.04, 95% CI [1.36–11.94]). This increased risk for cesarean after induction remained in both nulliparous and multiparous women even after controlling for confounders (aOR 2.90, 95% CI [1.60–5.25] and aOR 3.47, 95% CI [1.12–10.67], respectively). Neither starting cervical exam nor indication for induction altered this increased risk.

Conclusions—The increased risk of cesarean in women undergoing an induction is present regardless of parity and indication for induction. This should be taken into account when counseling women regarding risks of induction, regardless of parity. Future studies should focus on other clinical characteristics of induction that may mitigate this risk.

Keywords

Cesarean delivery; induction; multiparity

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Declaration of interest

The authors report no conflict of interest.

Introduction

The number of delivering women undergoing an induction of labor is greater than 20% and continues to rise [1]. Simultaneously, the cesarean delivery rate continues to increase as well. Multiple studies have suggested a higher risk of cesarean delivery among nulliparous women undergoing an induction compared to those that present in spontaneous labor [2–4]. There is some evidence suggesting an increased risk of cesarean delivery in multiparous women undergoing an induction as well [4,5]; however, other studies have not corroborated this risk [6–8].

The majority of these prior studies has focused on elective inductions and did not evaluate all indications for induction, specifically non-elective inductions including inductions for medical comorbidities, premature rupture of membranes (PROM), and post-term. Compared to women undergoing an elective induction, women undergoing a non-elective induction may be more likely to have a less favorable cervical exam and therefore may have an increased risk of cesarean delivery. Additionally, the underlying maternal or fetal reason why the woman is undergoing an induction may place them at an increased risk for cesarean delivery. The risk of cesarean delivery in inductions, particularly including non-elective inductions must be evaluated. Although the decision to induce may not be altered by a known increased risk of cesarean delivery, it is important in counseling and evaluation. Additionally, if there are characteristics that alter this risk, including parity and indication for cesarean delivery, interventions may be available to attenuate these risks.

Therefore, the objective of this study is to evaluate the risk of cesarean delivery among both nulliparous and multiparous women undergoing an induction of labor at term for any indication compared to women that present in spontaneous labor at term. Our hypothesis is that the risk of cesarean delivery is significantly increased among women undergoing an induction at term compared to women who present in spontaneous labor, regardless of parity and indication.

Methods

This was a planned secondary analysis of a large retrospective cohort study [9]. The parent study included women with two consecutive deliveries at the Hospital of the University of Pennsylvania during the period 2005–2010. It compared women that underwent a term (≥ 37 weeks) induction of labor to those that went into spontaneous labor at term and evaluated their rates of spontaneous preterm birth in a subsequent pregnancy. The first of the two deliveries included (index) is the focus of this study and may not equate to a patient's first pregnancy. Approval from the Institutional Review Board was obtained prior to initiation of the study.

Inclusion and exclusion criteria were based on the parent study and included women whose index pregnancy was at term (≥ 37 weeks gestation) and who had a consecutive subsequent delivery ≥ 16 weeks gestational age were included in the parent study. Women with a prior preterm birth history at the time of their index pregnancy were excluded based on the aim of

the parent study. Women with twin gestations, as well as women with a prior cesarean delivery were excluded from this analysis.

Women undergoing an induction of labor were identified using a combination of *International Classification of Disease, 9th edition* (ICD-9) codes (73.01, 73.1, 73.4) and detailed chart review. We were able to identify which patients underwent an induction and which ones presented in spontaneous labor and detailed chart review was performed to confirm our strict definitions as noted below. Data collection was through chart abstraction from the maternal and neonatal electronic medical records and was performed in parallel by two of the investigators (LDL, AH). Variables collected included maternal demographics, obstetrical history, medical history, and labor and delivery information.

We defined induction of labor as, (1) use of any cervical ripening agent (prostaglandin or cervical foley); (2) artificial rupture of membranes or oxytocin use in the setting of contractions with cervical dilation <4 cm; (3) cervical dilation of ≥ 4 cm in the absence of contractions. Spontaneous labor was defined by, (1) cervical dilation ≥ 5 cm or (2) cervical dilation ≥ 4 cm in the presence of documented cervical change. The spontaneous labor cohort was matched on day and year of admission as described in the parent study. Active labor was diagnosed when cervical exam was ≥ 5 cm in dilation. Multiparity was defined as a prior delivery ≥ 20 weeks' gestation.

Our objective was to evaluate the risk of cesarean delivery among nulliparous and multiparous women undergoing a term induction compared to those presenting in term spontaneous labor, stratified by parity. Our exposed group was women who underwent a term induction. Our unexposed group was women who presented in spontaneous labor at term.

The primary outcome for the study was cesarean delivery. Secondary outcomes included indication for cesarean delivery, postpartum hemorrhage rate and neonatal intensive care unit admission rate.

Our analysis occurred in two stages. The first part of the analysis compared demographic data between the two groups. Mann–Whitney U -tests were used to compare non-parametric data, t -tests were used to compare parametric data, and Chi-square tests were used to compare categorical variables.

The second part of the analysis used bivariate comparisons to assess for potential confounders or risk factors for the outcome. Based on analysis with our dependent variable, cesarean delivery, we included risk factors in our multivariable model that had an association at a significance level of $p < 0.2$. These included gestational age, presence of medical comorbidities, cervical dilation at time of induction and body mass index. We also included biologically plausible confounders including maternal age and race. We then created our multivariable model and used a backwards stepwise elimination strategy to obtain a parsimonious model. The confounders included in the final model were maternal age category (<18 years old, 18–35, ≥ 35 years), race and body mass index (BMI) category. While the Mantel–Haenszel estimate did not show parity to be an effective modifier, we

stratified by parity for our analysis given the previously reported differences in cesarean delivery risk among these women [2–5].

The parent study had 622 women in the induction group and 265 women in the spontaneous labor group. There were more women undergoing an induction in the parent study based on the primary objective and outcome. The analysis for the current study included 606 women in the induction group and 257 women in the spontaneous labor after all inclusion and exclusion criteria were met (Figure 1). We assumed a cesarean delivery rate for all women presenting in spontaneous labor to be 7%, as previously noted at our institution. Using an alpha of 0.05, a two-sided test, and a ratio of 2:1 of induction to spontaneous labor, we have 85% power to detect a 2-fold increase in the risk of cesarean delivery among women undergoing an induction compared to those in spontaneous labor.

Data analysis was performed using STATA 12.0 for Windows (STATA Corporation, College Station, TX). Statistical significance was set at $p < 0.05$.

Results

There were 863 women included in this analysis (606 and 257 women in the induction and spontaneous labor groups, respectively) (Figure 1). The demographic characteristics for the induction group and the spontaneous labor group are shown in Table 1. Women in the induction group had a significantly higher median BMI. There were also more women with chronic hypertension (CHTN) and pregnancy-related hypertension, defined as gestational hypertension and preeclampsia in the induction group compared to the spontaneous labor group. Finally, there were significantly more nulliparous women in the induction group compared to the spontaneous labor group. The indications for induction of labor are listed in Table 1. Among the induction cohort, 475 (78%) women had a starting cervical exam ≤ 2 cm, 131 (22%) women had a starting cervical exam > 2 cm, and 466 (77%) women had some form of cervical ripening agent (including misoprostol, dinoprostone or cervical foley).

The overall cesarean delivery rate for the entire cohort was 18%. The cesarean delivery rate was higher for women undergoing an induction compared to those presenting in spontaneous labor (23% versus 7%, OR 3.4 [2.1–5.4], $p < 0.001$). When stratified by parity, we found an increased risk of cesarean delivery in both nulliparous and multiparous women undergoing an induction compared to spontaneous labor. Among nulliparous women, those undergoing an induction have a 3-fold higher odds of having a cesarean delivery compared to those that present in spontaneous labor. Among multiparous women, those undergoing an induction have a 4-fold higher odds of having a cesarean delivery compared to those that present in spontaneous labor. The increased risk of cesarean delivery remains in both nulliparous and multiparous women after controlling for maternal age, race and BMI (Table 2).

To further understand the increased risk of cesarean delivery among women undergoing an induction, we evaluated the risk based on starting cervical exam and indication for induction. In nulliparous women, regardless of starting cervical exam, women undergoing an induction had a significantly higher cesarean delivery rate as compared to those

presenting in spontaneous labor (Table 3). Among multiparous women undergoing an induction, the odds of a cesarean delivery are higher with a starting cervical exam at induction of ≤ 2 cm compared to spontaneous labor. Among multiparous women with a starting cervical exam at induction of >2 cm, there is a trend toward increased risk of cesarean delivery; however, this is not statistically significant. When evaluating the risk of cesarean delivery by indication for induction, both nulliparous and multiparous women have a significantly higher odds of cesarean delivery if undergoing a non-elective induction (PROM, post-term, maternal comorbidity or fetal indication) compared to those presenting in spontaneous labor as seen in Table 3.

We then evaluated our secondary outcomes. The indications for cesarean delivery are listed in Table 4 by parity for both the induction group and the spontaneous labor group. The most common reason for cesarean delivery, regardless of parity or labor group, was non-reassuring fetal status. In our cohort, all multiparous women presenting in spontaneous labor had non-reassuring fetal status as the indication for cesarean delivery. Among both the induction and spontaneous labor groups, nulliparous women were more likely to have an arrest of labor in the first stage (defined as failed induction or arrest of dilation) compared to multiparous women (39% versus 14%, $p = 0.02$) whereas multiparous women were more likely to have an arrest in the second stage of labor compared to nulliparous women (24% versus 18%, $p = 0.04$).

There was a significantly higher rate of postpartum hemorrhage when comparing overall inductions to spontaneous labor (10% versus 3%, $p = 0.001$). Among the nulliparous women, the postpartum hemorrhage rate was 11% for inductions and 3% for spontaneous labor ($p = 0.003$) and 7% for multiparous inductions compared to 3% for multiparas presenting in spontaneous labor ($p = 0.12$). The neonatal intensive care unit admission rate was higher when comparing overall inductions to spontaneous labor (9% versus 3%, $p = 0.001$). Among nulliparous women, the admission rate was 11% for inductions and 4% for spontaneous labor ($p = 0.072$) and 7% for multiparous inductions compared to 2% for multiparas presenting in spontaneous labor ($p = 0.031$).

Discussion

We evaluated the risk of cesarean delivery among women undergoing a term induction compared to women that present in spontaneous labor at term, with approximately 90% of the inductions being non-elective. We found a significantly higher risk of cesarean delivery after an induction, regardless of parity. This risk remained after controlling for confounders. As hypothesized, the cesarean delivery risk was higher for all women undergoing an induction of labor as compared to those presenting in spontaneous labor. This holds true for multiparous women who were found to have a 4-fold higher risk of cesarean after an induction as compared to women presenting in spontaneous labor despite having a prior full term vaginal delivery.

Previous literature has been conflicting regarding the risk of cesarean delivery among multiparous women undergoing an induction [2–6,8,10]. Our findings strongly support prior literature that suggested an increased risk of cesarean delivery after induction, even in

multiparous women. The majority of the prior literature on this topic focused on elective inductions and did not include non-elective or medically indicated inductions. Jacquemyn et al. evaluated the cesarean delivery risk among low risk multiparous women after an elective induction at term [10]. They found a 2-fold increased risk of cesarean delivery; however, this study did not include all indications for induction and did not review the charts to verify whether an induction or spontaneous labor had occurred. Hoffman et al. also evaluated labor progression and cesarean delivery risk among multiparous women undergoing an elective induction [5]. Although they had an unusually low cesarean delivery rate, they did find an increased risk of cesarean delivery among the multiparous inductions as compared to spontaneous labor (3.9% versus 2.3%, $p<0.05$).

Our study demonstrates that inductions had an increased risk of cesarean delivery, even in multiparous women. The increased risk for cesarean delivery is multifaceted and is likely due, in part, to a less favorable starting cervical exam as well as the underlying indication that is leading to the induction. When evaluating whether or not a particular indication for induction was driving the increased risk for cesarean, we found that all inductions, regardless of indication, were associated with an increased risk of cesarean delivery. This held true for both nulliparous and multiparous women. The practice of elective inductions is uncommon at our institution and therefore the small number of these inductions likely accounts for the non-significant association that was noted in this small sub-group.

Our study has several strengths. It is one of the small number of studies that includes all term inductions to evaluate the risk of cesarean delivery after induction. It is a large cohort study using data from one large urban hospital that minimizes practice variation during labor and delivery. Exposure status was confirmed using detailed chart abstraction and data collection that was performed solely by two investigators (LDL, AH) with the use of strict definitions for induction and spontaneous labor to limit misclassification bias. Additionally, our cesarean delivery rate is comparable to the primary cesarean delivery rate suggested by Zhang et al. [11] making our findings generalizable to other centers.

Our study was not without limitations. First, it was a planned secondary analysis of a primary study and therefore the initial study population was not chosen to specifically answer this study question. Nevertheless, we were adequately powered to answer the planned study question proposed. This study was not; however, powered to evaluate all of the indications for induction separately and therefore small differences among the various indications may not have been appreciated. Additionally, this cohort included women with two deliveries at the same institution which may not reflect the general population. Further, we used cervical dilation rather than a bishop's score because a full bishop's score was not available on all patients. Lastly, inherent in the way we defined induction, there is potential for patients in early spontaneous labor to be misclassified as an induction. It is unclear how this would affect the results because the exact risk of cesarean for these women was not evaluated. Within this cohort of women, if the risk of cesarean is lower because they presented in spontaneous labor, this would bias our study to the null. If their risk of cesarean was higher because they needed augmentation, this would bias our study away from the null.

In a study on induction of labor, it is important to address the control group that was chosen. When evaluating the cesarean risk among elective inductions, the most appropriate control group would be those who were expectantly managed. However, nearly 90% of women in this study had non-elective inductions. Since expectant management is not an option in medically indicated inductions, we did not feel that expectant management was the appropriate control group. Therefore, we compared to those that underwent an induction to those that presented in spontaneous labor.

Novel to our study is the inclusion of all indications for induction as the exposed group and is not limited to those only undergoing an elective induction. The finding of an increased risk of cesarean delivery, regardless of parity and indication for induction, is significant and of public health concern. Given that the percentage of elective inductions are decreasing and non-elective inductions are increasing, it is important to be aware of this increased risk of cesarean delivery when counseling these patients, regardless of whether or not it would change the need for the induction. Future studies should focus on more specific indications for induction to evaluate the subgroups that are at the highest risk. Strategies to decrease the risk in these patients can then be targeted.

Acknowledgments

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References

1. American College of Obstetrics & Gynecology Practice Bulletin. Induction of Labor. Aug. 2009
2. Luthy DA, Malmgren JA, Zingheim RW. Cesarean delivery after elective induction in nulliparous women: the physician effect. *Am J Obstet Gynecol.* 2004; 191:1511–15. [PubMed: 15547518]
3. Vahratian A, Zhang J, Troendle JF, et al. Labor progression and risk of cesarean delivery in electively induced nulliparas. *Obstet Gynecol.* 2005; 105:698–704. [PubMed: 15802393]
4. Maslow AS, Sweeny AL. Elective induction of labor as a risk factor for cesarean delivery among low-risk women at term. *Obstet Gynecol.* 2000; 95:917–22. [PubMed: 10831992]
5. Hoffman MK, Vahratian A, Sciscione AC, et al. Comparison of labor progression between induced and noninduced multiparous women. *Obstet Gynecol.* 2006; 107:1029–34. [PubMed: 16648407]
6. Macer JA, Macer CL, Chan LS. Elective induction versus spontaneous labor: a retrospective study of complications and outcome. *Am J Obstet Gynecol.* 1992; 166:1690–6. discussion 1696–7. [PubMed: 1615976]
7. Dublin S, Lydon-Rochelle M, Kaplan RC, et al. Maternal and neonatal outcomes after induction of labor without an identified indication. *Am J Obstet Gynecol.* 2000; 183:986–94. [PubMed: 11035351]
8. Heinberg EM, Wood RA, Chambers RB. Elective induction of labor in multiparous women. Does it increase the risk of cesarean section? *J Reprod Med.* 2002; 47:399–403. [PubMed: 12063879]
9. Levine LD, Bogner H, Hirshberg A, et al. Term induction of labor and subsequent preterm birth. *Am J Obstet Gynecol.* 2013; 210 Epub ahead of print.
10. Jacquemyn Y, Michiels I, Martens G. Elective induction of labour increases caesarean section rate in low risk multiparous women. *J Obstet Gynaecol.* 2012; 32:257–9. [PubMed: 22369399]
11. Zhang J, Troendle J, Reddy UM, et al. Contemporary cesarean delivery practice in the United States. *Am J Obstet Gynecol.* 2010; 203:326, e1–e10. [PubMed: 20708166]

Figure 1.
Flow of patients included.

Table 1

Demographic information.

	Induction group (<i>n</i> = 606)	Spontaneous labor group (<i>n</i> = 257)	<i>p</i> Value
Maternal age (years)*	24 (19–30)	23 (19–28)	0.10
Gestational age at delivery (weeks)*	39.9 (38.9–41.0)	39.7 (38.9–40.4)	0.09
BMI (kg/m ²)*	26.7 (22.7–31.6)	24.7 (21.6–29.6)	0.001
BMI categories [†]			
Underweight	20 (3)	8 (3)	0.010
Normal weight	213 (36)	116 (48)	
Overweight	184 (31)	62 (26)	
Obese	179 (30)	55 (23)	
Race [‡]			
Black/AA	438 (72)	187 (73)	0.70
White	99 (16)	34 (13)	
Asian	24 (4)	12 (5)	
Latino	9 (2)	7 (3)	
Other	9 (2)	3 (1)	
Unknown	27 (4)	14 (5)	
Medical comorbidities [‡]			
CHTN	25 (4)	2 (1)	0.01
GDM	11 (2)	2 (1)	0.50
Pregnancy-related hypertension [¶]	139 (23)	13 (5)	<0.001
Birth weight (g) [‡]	3272 (±519)	3279 (±437)	0.85
Parity [‡]			
Nulliparas	414 (68)	140 (54)	<0.001
Multiparas	192 (32)	117 (46)	
Indication for induction [‡]			
Maternal	152 (25)	NA	NA
Fetal	193 (32)		
Premature rupture of membranes	83 (14)		
Post-term	113 (19)		
Elective	65 (11)		

BMI: body mass index; AA: African American; CHTN: chronic hypertension; GDM: gestational diabetes.

* Medians and inter-quartile ranges reported;

[†] *n* (%);[‡] mean (standard deviation).[¶] Pregnancy-related hypertension – includes gestational hypertension and preeclampsia.

Table 2

Cesarean delivery rate by parity among the induction group compared to the spontaneous labor group.

	Cesarean rate in induction group *	Cesarean rate in spontaneous labor group *	OR	CI	p Value	aOR [†]	CI	p Value
Nulliparas (n = 554)	113 (27)	15 (11)	3.13	1.76–5.57	<0.001	2.90	1.60–5.25	<0.001
Multiparas (n = 309)	24 (13)	4 (3)	4.04	1.36–11.94	0.012	3.47	1.12–10.67	0.030

* n (%);

[†] Adjusted for maternal age, race and BMI.

Table 3

Risk of cesarean delivery based on starting cervical exam and indication for induction as compared to spontaneous labor, stratified by parity.

	OR	CI	p Value	aOR*	CI	p Value
Nulliparas: Starting cervical exam at induction						
Cervix 2 cm (n = 349)	3.21	1.79–5.76	<0.001	2.97	1.63–5.42	<0.001
Cervix >2 cm (n = 65)	2.72	1.25–5.92	0.012	2.55	1.15–5.68	0.021
Multiparas: Starting cervical exam at induction						
Cervix 2 cm (n = 126)	4.41	1.44–13.51	0.009	3.57	1.11–11.52	0.033
Cervix >2 cm (n = 66)	3.35	0.94–11.91	0.062	3.28	0.89–12.09	0.074
Nulliparas: Indication for induction						
PROM/post-term (n = 146)	3.83	2.02–7.27	<0.001	3.62	1.88–6.99	<0.001
Maternal/fetal (n = 233)	3.29	1.80–6.04	<0.001	3.00	1.61–5.60	0.001
Elective (n = 35)	0.25	0.031–7.92	0.18	0.22	0.027–1.72	0.15
Multiparas: Indication for induction						
PROM/post-term (n = 50)	4.60	1.28–16.50	0.019	3.54	0.92–13.58	0.065
Maternal/fetal (n = 112)	4.04	1.29–12.66	0.017	3.89	1.18–12.79	0.025
Elective (n = 30)	3.14	0.66–14.89	0.15	2.03	0.34–12.19	0.44

PROM: premature rupture of membranes.

* Adjusted for maternal age, race and BMI.

Table 4

Indication for cesarean delivery by the labor group and parity.

	Induction (cesarean delivery $n = 136$) n (%) [*]	Spontaneous labor (cesarean delivery $n = 20$) n (%) [†]	p Value [‡]
Failed induction of labor	23 (17)	0	NA
Nullipara	21 (19)	0	
Multipara	2 (8)	0	
Arrest of dilation	25 (18)	2 (10)	0.40
Nullipara	22 (20)	2 (13)	0.57
Multipara	3 (13)	0	0.45
Arrest of descent	25 (18)	4 (20)	0.77
Nullipara	19 (17)	4 (27)	0.35
Multipara	6 (25)	0	0.26
Non-reassuring fetal status	60 (44)	11 (55)	0.47
Nullipara	48 (43)	6 (40)	0.89
Multipara	12 (50)	5 (100)	0.06
Other [¶]	3 (2)	3 (15)	0.004
Nullipara	2 (3)	3 (20)	0.001
Multipara	1 (4)	0	0.68

^{*} n = number of cesarean deliveries among those being induced, % = percentage of cesarean deliveries for that indication among those being induced.

[†] n = number of cesarean deliveries among those with spontaneous labor, % = percentage of cesarean deliveries for that indication among those in spontaneous labor.

[‡] These p values are comparing induction to spontaneous labor overall, among the nulliparas, and among the multiparas for each indication for cesarean.

[¶] Other includes maternal request, malpresentation.