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Induction of labor at 39 weeks and risk of cesarean delivery among obese women: a retrospective propensity score matched study

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Abstract

Objectives: To evaluate if induction of labor (IOL) in obese women at 39 weeks of gestation decreases the risk of cesarean delivery (CD).

Methods: We conducted a retrospective propensity score matched study using the Center for Disease Control's (CDC's) Period Linked Birth-Infant Death data. The study population consisted of cephalic singleton births to women with BMI greater or equal to 30.0 kg/m² who delivered at or beyond 39 weeks between 2013 and 2017. Women with prior CD were excluded. Women who underwent IOL at 39 weeks were propensity score matched 1:5 on the basis of CD risk factors to women who did not undergo IOL at 39 weeks but may have had an IOL at a later gestational age. Conditional logistic regression compared CD rates and maternal outcomes between obese women induced at 39 weeks with those not induced at 39 weeks.

Results: Our cohort consisted of 197,343 obese women induced at 39 weeks and 986,715 obese women not induced at 39 weeks. Overall, the risk of CD among women who had an IOL at 39 weeks was lower than those without an IOL at 39 weeks, 0.59 (0.58–0.60). The decrease in CD risk was more pronounced in multiparas, 0.47 (0.46–0.49) than nulliparas, 0.81 (0.79–0.83). When stratified by BMI, the effect of IOL on lowering CD risk was similar across all obesity classes. Aside from an increased risk of

instrumental deliveries, morbidities were comparable in both groups.

Conclusions: IOL at 39 weeks among obese women appears to lower the risk of CD, without compromising maternal outcomes.

Keywords: cesarean delivery; induction of labor; obesity; pregnancy.

Introduction

Obesity is a worldwide epidemic that has continued to increase for many years. In 2015, 609 million people globally were estimated to be obese and from 1980 to 2015, the prevalence of obesity increased by 80% [1]. Obesity is generally defined by the World Health Organization (WHO) definition of a body mass index (BMI), expressed in kg/m², of 30 or more [2]. The prevalence of obesity in women of reproductive age (20–39 years old) in the United States of America (USA), in 2016, was 36.5% [3].

Obese women are known to have a higher risk of cesarean delivery (CD) compared to women with a normal BMI [4–7]. This is due to a decreased cervical dilation rate, the presence of comorbid conditions, cephalopelvic disproportion, fetal macrosomia, excess weight gain during pregnancy, and a prolongation of pregnancy, which is associated with a risk of maternal postdates [8–10]. Furthermore, there is an increased risk of complications from CD, such as wound infections and endometritis, in obese women compared to women with a normal BMI [11, 12]. Currently, there is contradicting evidence if induction of labor (IOL) in obese women increases the risk of CD. Several studies have demonstrated an increase in failure of IOL in the obese parturient compared to a normal BMI parturient [13–17]. However, other studies have demonstrated the opposite [18–20]. Although not specifically targeting the obese population, the ARRIVE trial, a randomized controlled trial, demonstrated a decreased risk of CD with IOL at 39 weeks in a nulliparous woman [21]. The purpose of this study was to evaluate if IOL at 39 weeks in the obese women is similarly effective in reducing CD rates.

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Materials and methods

Data source

We conducted a retrospective population-based propensity score matched cohort study using the Center for Disease Control and Prevention (CDC)'s Period Linked Birth-Infant Death data set files from 2013 to 2017, inclusively [22]. This data set includes all registered births to USA citizens occurring within the USA, including the District of Columbia. It does not include births of U.S. citizens outside of the USA.

Study population

The study population included all live births from the dataset. We excluded deliveries prior to 39 weeks and after 43 weeks of gestation, or from an unknown gestational age (Figure 1). Deliveries from women with a BMI of less than 30.0 kg/m², with an unknown BMI or an unknown IOL status were excluded; hence, our cohort included women with a BMI of 30.0 kg/m² or more. In addition, births that were non-cephalic, multi-gestational, and that had congenital anomalies were also excluded. Deliveries from women with a prior CD were excluded. Our final cohort consisted of cephalic births without congenital malformations between 39 and 43 weeks from obese women who did not have a prior CD.

The exposure group consisted of women who were induced at 39 weeks' gestation. After propensity score matching using a 1:5 ratio, they were compared to women who were not induced at 39 weeks' gestation, regardless of how labor was managed at later gestational ages. More specifically, this comparison group consisted of women

who either delivered at 39 weeks without being induced or women who delivered at a later gestational age, with or without being induced. Matching was carried out using SAS Proc PSMATCH with greedy nearest neighbors random matching to women who were not induced at 39 weeks on the basis of CD risk factors. The variables included in the propensity score matching were BMI, chronic and gestational hypertension, gestational and pre-gestational diabetes, preeclampsia, age, race, education, smoking status, and parity. The primary outcome was the risk of cesarean section and the secondary outcomes included maternal obstetrical outcomes.

Statistical analysis

We carried out three analyses. First, we carried out descriptive statistics comparing baseline maternal characteristics and risk factors between obese women who were induced vs. those who were not induced. These included maternal age, race, BMI class, highest education level, smoking status, parity, insurance type, chronic hypertension, pre-gestational diabetes, gestational hypertension, gestational diabetes, preeclampsia, gestational age at delivery, and IOL status. The second analysis was to compare the risk of CD in groups using multivariate logistic regression models adjusted for baseline characteristics, with births to women not induced at 39 weeks of gestation as the reference group. Stratified analyses were carried out to evaluate the effect of parity and BMI category on the IOL, using BMI as a categorical and continuous variable. Third, we carried out adjusted logistic regression analysis to evaluate the effect of IOL at 39 weeks on maternal morbidities including instrumental deliveries, maternal transfusion, ruptured uterus, unplanned hysterectomy, admission to intensive care unit (ICU), and chorioamnionitis.

Analyses were performed with the statistical software package SAS Enterprise Guide 6.1 (Cary, NC, USA). As per the Tri-Council Policy Statement of 2010, this study was exempt from Institutional Review Board Ethics approval since all data used were publicly available.

Figure 1: Creation of study cohort.

Results

From 2013 to 2017, inclusively, a total of 19,762,499 births were identified in the dataset (Figure 1). Among them, 3,507,919 deliveries were excluded from our analysis, as they were characterized by one or more of the following: birth from a woman with an unknown BMI or a BMI of less than 30.0, birth from a woman with a prior CD, gestational age of delivery of less than 39 weeks or more than 43 weeks, gestational age unknown, non-cephalic presentation, IOL status unknown, multifetal gestation, or anomalous birth. After these exclusions, 2,147,014 singleton, non-anomalous, vertex deliveries between 39 and 43 weeks of gestation from obese women with no prior CD remained. Of the births in our cohort, 375,928 were from women who were induced at 39 weeks and 1,771,086 were from women who were not induced at 39 weeks. Propensity score matching in a 1:5 ratio, yielded 197,343 births from women with IOL at 39 weeks and 986,715 births

from women who did not receive an IOL at 39 weeks, for a total of 1,184,058 births in the study.

The maternal baseline characteristics are listed in Table 1. Given that propensity score matching was performed, the baseline characteristics were comparable in both groups. By design, all women in the IOL group delivered at 39 weeks and women in the comparison group delivered at 39 weeks without an IOL or at a later gestational age, either being induced or not. Similarly, all women in the IOL at 39 weeks group were induced and one fourth of women in the comparison group went on to undergo IOL at a later gestational age.

The effect of IOL at 39 weeks on the risk of CD is listed in Table 2. Overall, the odds of CD among obese women who had an IOL at 39 weeks was lower than those of women not induced at 39 weeks. The decrease in the risk of CD was more significant in multiparas compared to nulliparas. When stratified by BMI, there was a similar decrease in the risk of CD for each class of obesity when comparing women who were induced at 39 weeks to those who were not induced at 39 weeks. When using BMI as a continuous variable, for every unit increase in BMI there was a 0.59-fold (95% CI 0.58–0.60) decrease in the risk of CD with IOL.

The effect of IOL at 39 weeks on maternal morbidities is listed in Table 3. The risk of instrumental delivery is increased in women who underwent IOL at 39 weeks. The risks of transfusion, uterine rupture, unplanned hysterectomy, ICU admission and chorioamnionitis were not statistically different between the two groups.

Discussion

The objective of this study was to determine if obese women induced at 39 weeks have a decreased risk of CD, without compromising obstetrical maternal outcomes. We carried out a retrospective population-based matched cohort study using propensity-score matching to compare the outcomes of obese women induced at 39 weeks with women not induced at 39 weeks. Our results suggest that there is an overall decrease in the risk of CD in obese women who are induced at 39 weeks compared to those not induced at that gestational age. In multiparous women, the protective effect of IOL at 39 weeks on CD is more pronounced than in nulliparous women. The decrease in CD risk appeared similar throughout all obesity classes.

We conducted our study using the CDC's Period Linked-Infant Death Public Use File database. This database is a large population-based cohort of all births in the USA that obtains its data from birth certificates and it has been used extensively to obtain population-based data.

Table 1: Baseline characteristics by IOL group.

Characteristic	IOL at 39 weeks, % (n=197,343)	No IOL at 39 weeks, % (n=986,715)
Age, years		
<20	6.0	6.1
20–24	27.1	27.2
25–35	56.2	55.9
35–40	9.4	9.5
≥40	1.4	1.3
Race		
Caucasian	50.8	50.3
African American	21.0	21.7
Hispanic	22.6	22.4
Other	5.6	5.6
BMI class, kg/m ²		
Obese I (30.0–34.9)	61.2	60.9
Obese II (35.0–39.9)	24.8	24.9
Obese III (≥40)	14.0	14.1
Parity		
0	36.2	36.7
1	31.1	31.0
2	16.4	16.1
≥3	16.3	16.2
Gestational age of delivery, weeks		
39	100.0	34.3
40	0	39.1
41	0	18.3
42	0	5.5
43	0	2.8
Induction of labor	100.0	24.0
Education		
Some high school	15.6	15.5
High school graduate	30.4	30.2
College	32.3	32.6
University and beyond	21.7	21.8
Insurance type		
Medicaid	50.9	50.0
Private	43.8	42.9
Self pay	1.9	3.2
Other	3.4	3.9
Smoker	6.3	6.2
Chronic hypertension	<0.1	<0.1
Gestational hypertension	<0.1	<0.1
Pre-eclampsia	<0.1	<0.1
Pre-pregnancy diabetes	<0.1	<0.1
Gestational diabetes	<0.1	<0.1

IOL, induction of labor; BMI, body mass index.

The population-based nature of this dataset allows for information to be collected in an unbiased manner and allows for a better generalization of the study results to the American population. The large number of births used in the study also gives significant power to the statistical analyses and allows for secondary analyses to be conducted.

Table 2: Adjusted logistic regression analysis comparing the odds of cesarean delivery among 986,715 births to women with no IOL at 39 weeks with 197,343 births to women with IOL at 39 weeks. Stratification for parity and BMI class.

	IOL, % (n=197,343)	No IOL, % (n=986,715)	Adjusted OR ^a (95% CI)	Adjusted p-value ^a
Cesarean delivery	20.05	24.68	0.59 (0.58–0.60)	<0.001
Parity				
Nulliparous	36.81	36.89	0.81 (0.79–0.83)	<0.0001
Multiparous	10.66	17.67	0.47 (0.46–0.49)	<0.0001
Obesity class				
Obese class I	17.34	21.50	0.58 (0.57–0.60)	<0.0001
Obese class II	22.04	26.69	0.59 (0.57–0.62)	<0.0001
Obese class III	28.40	34.80	0.60 (0.58–0.63)	<0.0001
Wald test	–	–	0.59 (0.58–0.60)	<0.0001

IOL, induction of labor. ^aAdjusted for age, race, BMI class, parity, gestational age of delivery, education, insurance type, smoking status, hypertension, gestational hypertension, pre-eclampsia, diabetes, and gestational diabetes.

Table 3: Maternal outcomes by IOL group.

Maternal outcome	IOL, % (n=197,343)	No IOL, % (n=986,715)	Adjusted OR ^a (95% CI)	Adjusted p-value ^a
Instrumental delivery	3.56	3.01	1.10 (1.05–1.15)	<0.0001
Transfusion	0.22	0.19	0.94 (0.79–1.13)	NS
Ruptured uterus	0.01	0.01	1.21 (0.54–2.75)	NS
Unplanned hysterectomy	0.02	0.01	0.87 (0.46–1.63)	NS
ICU admission	0.06	0.06	0.87 (0.63–1.20)	NS
Chorioamnionitis	1.50	1.65	1.00 (0.94–1.07)	NS

IOL, induction of labor; ICU, intensive care unit; NS, non-significant. ^aAdjusted for age, race, BMI class, parity, gestational age of delivery, education, insurance type, smoking status, hypertension, gestational hypertension, pre-eclampsia, diabetes, and gestational diabetes.

Our study consisted of women who underwent labor induction anytime during 39 weeks of gestation. The CDC database, which retrieves its data from birth certificates in the USA, does not specify the different methods of IOL. According to studies that examined the concordance of labor induction derived from birth certificates, the IOL on birth certificates is underreported [23]. Therefore, women who are induced are subject to misclassification. Since IOL is underreported, this differential misclassification would bias our findings towards the null. With regards to our results, this creates an underestimation of the association of IOL and a decreased risk of CD and suggests that the magnitude of the association is in fact greater.

The principal outcome in our study was the risk of CD. The validity for CDs in the CDC database is strong. In one study comparing the records of births in two states between birth certificates and hospital medical record data, exact agreement or sensitivity was high within both states for CD [24]. Another study that evaluated the reliability of birth certificate data compared to medical records showed that agreement was very good for CD [25].

Our results suggest that there is a lower risk of CD in obese patients with IOL at 39 weeks. While many studies have consistently demonstrated that the risk of CD increases with BMI class when obese women are compared to non-obese women [13–17], these tended to be extrapolated as suggesting that IOL was not beneficial in obese women. Rather, our study suggests that obese women who are induced at 39 weeks have a significant lower risk of having a CD compared to appropriately matched women who were not induced at 39 weeks. The protective effect of IOL is more pronounced in multiparas (0.47 [95%CI 0.46–0.49]) compared to nulliparas (0.81 [95%CI 0.79–0.83]). The effect of IOL at 39 weeks is similar among all obesity classes. There are no significant differences in maternal morbidities besides an increase in the risk of instrumental delivery.

The ARRIVE study, a randomized control trial of IOL vs. expectant management at 39 weeks in low-risk nulliparous women, supports the results of our study. The frequency of CD in the group randomized to IOL at 39 weeks was significantly lower compared to those who had expectant management (RR 0.84 [95% 0.76–0.93]), with no difference

in adverse perinatal outcomes [21]. To our knowledge, few studies have evaluated the risk of CD in obese women by comparing IOL vs. expectant management prior to 40 weeks. Another retrospective cohort study that supports our findings, demonstrates a lower risk CD in nulliparas and multiparas who were induced at 39 weeks compared to those who were expectantly managed [20].

Due to the increasing proportion of obesity in pregnancy, our study is of great importance because it suggests IOL at 39 weeks as an effective method in decreasing the risk of CD in obese women. This is significant because obese women at term are known to have an increased rate of CD compared to women with a normal BMI and clinicians are often hesitant to induce this subset of the population due to various factors such as failure to progress and an unfavorable cervix [8, 10]. A retrospective study evaluating IOL at term in obese women with an unfavorable cervix demonstrated that as BMI increases, obese patients require a longer time to delivery and have a higher cesarean rate delivery [14]. Contrary to the existing literature which demonstrate increased rates of failed IOL in the obese parturient due to factors such as an unfavorable cervix, our study suggests that IOL at 39 weeks actually decreases the risk of CD and that inducing these patients before 40 weeks could be a way of reducing their CD rates.

We used propensity score matching in the analysis to account for covariates that would influence a patient's risk of being induced and to deliver by cesarean section. In observational studies, the exposure, as in this case IOL, is often influenced by individual characteristics, such as maternal comorbidities. Therefore, an unbiased estimate of the effect of IOL on the risk of CD cannot be obtained by directly comparing the risk of CD in those who are induced compared to those who are not induced. Propensity score matching eliminates bias from such confounders by matching so that the distribution of baseline characteristics is similar between the two groups. Although adjusted logistic regression analysis was also used, propensity score matching was the best method to control for confounding because it takes into account the maternal characteristics that would differ between women who are induced at 39 weeks and those who are not induced at 39 weeks. Obese women are at an increased risk of antepartum complications and are therefore more likely to require IOL or a CD than normal weight women [26].

One of the limitations of our study is that we performed a retrospective cohort study using a large population database, which can lead to coding errors, missing data, and data entry errors. Another major limitation is the possibility of confounding by indication. Obese women who undergo IOL at 39 weeks most likely have risk factors

that increase their likelihood of CD. By using propensity score matching, we accounted for known risk factors that would influence the decision to induce a patient at 39 weeks and that are also linked to an increase in CD rates. However, the only way to completely account for all unknown confounders is by performing a randomized controlled trial.

There are several strengths in our study. One of the strengths of this study is its large cohort size. We used a large population cohort which included all births in the USA. This allowed us to explore a high-risk subset of the population and provided sufficient power to detect significant rare secondary outcomes. Finally, our study is population-based. Compared with hospital-based studies, this allowed for information to be collected in an unbiased manner and allowed for a more reliable and accurate representation of the results in the American population.

Conclusions

Our study suggests that IOL at 39 weeks in obese women is associated with a decreased risk in CDs without resulting in an increase in maternal morbidity. Consideration should be given to advising women with a BMI of 30.0 or greater that induction of labor may reduce their rates of CD without resulting in adverse maternal outcomes.

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Informed consent: Informed consent was obtained from all individuals included in this study.

Ethical approval: As per the Tri-Council Policy Statement of 2010, this study was exempt from Institutional Review Board ethics approval since all data used were publicly available.

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