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Nulliparous with Class III Obesity at Term: Labor Induction or Cesarean Delivery without Labor

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Abstract

Objective This study aimed to compare maternal and neonatal outcomes between labor induction versus cesarean delivery (CD) without labor among nulliparous individuals with class III obesity (body mass index [BMI] ≥ 40 kg/m²).

Study Design A retrospective cohort study of all nulliparous singleton deliveries at ≥ 37 weeks with a BMI of ≥ 40 kg/m² at delivery between March 2020 and February 2022. We excluded individuals with spontaneous labor, fetal malformations, and stillbirths. The primary outcome was a composite of maternal mortality and morbidity, including infectious and hemorrhagic morbidity. The secondary outcome was a neonatal composite. A subgroup analysis evaluated patients with a BMI of ≥ 50 kg/m². Another subgroup analysis compared outcomes between CD without labor and an indicated CD following induction. A multivariable logistic regression was applied. For adjustment, we used possible confounders identified in a univariate analysis.

Results Among 8,623 consecutive deliveries during the study period, 308 (4%) met the inclusion criteria. Among them, 250 (81%) underwent labor induction, and 58 (19%) had a CD without labor. The most common indications for CD without labor were fetal malpresentation (26; 45%), suspected macrosomia (8; 14%), and previous myomectomy (5; 9%). Indicated CD occurred in 140 (56%) of the induced individuals, with the two leading indications being labor arrest (87; 62%) and non-reassuring fetal heart rate tracing (51; 36%). The rates of composite maternal morbidity (adjusted odds ratio [aOR] = 2.14, 95% confidence interval [CI]: 0.64–7.13) and composite neonatal morbidity (aOR = 3.62, 95% CI: 0.42–31.19) did not differ following a CD without labor compared to labor induction. The subgroup analyses did not demonstrate different outcomes between groups.

Conclusion Among nulliparous individuals with class III obesity at term who underwent induction, more than 50% had indicated CD; the rate of short-term maternal and neonatal morbidity, however, did not differ between labor induction and CD without labor.

Keywords

- ▶ cesarean delivery
- ▶ induction of labor
- ▶ body mass index
- ▶ obesity

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Key Points

- The rate of unplanned CD among those who underwent labor induction was relatively high (56.0%).
- Outcomes did not differ between those who underwent CD without labor and those who were induced.
- Outcomes also did not differ between those who underwent CD without labor and those with CD in labor.

Obesity, an expanding pandemic, is associated with an increased risk for peripartum and neonatal complications, including infection, hemorrhage, and neonatal morbidity.^{1–5} Labor induction rates have also been rising across the United States in recent years.⁶ Patients with obesity reportedly have increased induction of labor (IOL) rates.^{7,8} Given the rising rates of both obesity and IOL and the connection between the two, research regarding the mode of delivery among individuals with obesity has gained focus.^{9–15}

Body mass index (BMI) was demonstrated to have a linear association with cesarean delivery (CD) rates.^{9–11} Among individuals with class III obesity (BMI ≥ 40 kg/m²), which consists of around 10% of the reproductive-age female population, IOL was associated with increased CD rates compared to spontaneous labor.^{12,16} Moreover, class III obesity was associated with a higher CD rate among patients who underwent labor induction compared to those with lower BMI.¹⁷ Nulliparous individuals with class III obesity undergoing induction, compared to multiparous, had exceptionally high rates of indicated CD (53–66%).^{12,13}

Such high rates of indicated CD following induction warrant examining whether a CD without labor might be an appropriate alternative for this population subset, especially in lieu of the possible increased risk of maternal and neonatal complications following an indicated CD after labor.^{12–14} Indicated CD was associated with higher rates of operative complications, maternal infectious morbidity, and adverse perinatal outcomes.^{12–14} Two previous studies compared maternal and neonatal outcomes following CD without labor versus planned vaginal delivery, showing no major differences between groups.^{14,18} However, both studies included multiparous patients, and only one compared IOL with CD without labor.

The objective of this study was to compare maternal and neonatal outcomes between IOL versus CD without labor among nulliparous individuals with class III obesity.

Materials and Methods

This was a retrospective cohort study of all nulliparous singleton deliveries at ≥ 37 weeks with a BMI of ≥ 40 kg/m² at delivery. The study was conducted at a single, level IV center between March 2020 and February 2022. We excluded individuals with spontaneous labor, fetal malformations, and stillbirths. All data were gathered from electronic medical records and entered into an electronic data capture tool (REDCap; Vanderbilt University, Nashville, TN). This study was approved by our Institutional Review Board (approval no.: HSC-MS-21-0383).

The primary outcome of this study was a composite of clinically relevant maternal morbidities, including infectious

morbidity, hemorrhagic morbidity, venous thromboembolism, intensive care unit admission, and maternal death. Infectious morbidity included endometritis and surgical site infection. Hemorrhagic morbidity included blood transfusion, mechanical tamponade (defined as a recorded use of a Bakri balloon tamponade for postpartum hemorrhage), surgical tamponade (defined as any of the following procedures in the context of postpartum hemorrhage: O'Leary, B-Lynch, uterine artery embolization), and hysterectomy.

The secondary outcome was a composite of neonatal morbidity, including neonatal ventilation (defined as mechanical ventilation > 6 h), seizures, sepsis, meconium aspiration syndrome, brachial plexus palsy, hypoxic–ischemic encephalopathy, and neonatal death.

We compared the primary and secondary outcomes among individuals who underwent labor induction versus those who had a CD without labor. We also performed two subgroup analyses: the first compared outcomes between individuals who had a CD without labor and those with an indicated CD following induction, and the second analysis was restricted to those with a BMI of ≥ 50 kg/m², comparing CD without labor and labor induction.

Differences in maternal characteristics between the groups were evaluated using the chi-square test or Fisher's exact test for categorical variables, as appropriate. We assessed correlations among variables using the Pearson correlation test and removed strongly clinically and statistically correlated variables. We then assessed the goodness of fit using the Hosmer–Lemeshow test. Multivariable logistic regression was applied, and the adjusted odds ratio (aOR) with 95% confidence intervals (CIs) was calculated while adjusting for possible confounders identified in a univariate analysis. All tests were two-tailed, and $p < 0.05$ was used to define significance. Statistical analyses were conducted using the IBM Statistical Package for the Social Sciences (v.25; IBM Corporation Inc., Armonk, NY). STROBE guidelines for reporting observational studies were followed throughout the manuscript.

Results

Among 8,623 consecutive deliveries during the study period, 308 (3.6%) met the inclusion criteria. Among them, 250 (81.2%) underwent labor induction, and 58 (18.8%) had a CD without labor (– Fig. 1). The most common indications for CD without labor were fetal malpresentation (26; 44.8%), suspected macrosomia (8; 13.8%), and previous myomectomy (5; 8.6%). Labor induction was performed using mainly a cervical ripening balloon (134; 53.6%) or prostaglandins (69; 27.6%). Indicated CD occurred in 140 (56.0%) of the induced individuals, with the two leading indications being labor

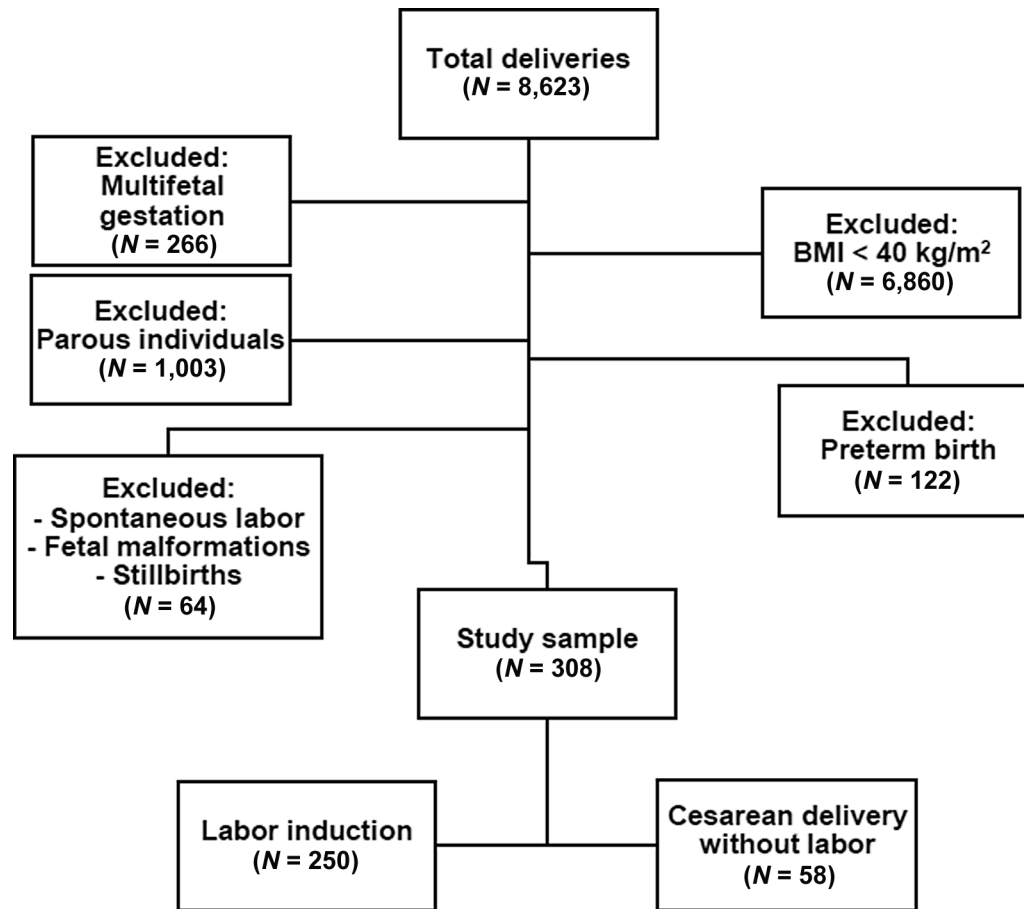


Fig. 1 Flow diagram. BMI, body mass index.

arrest (87; 62.1%) and non-reassuring fetal heart rate tracing (51; 36.4%).

Compared to the patients who underwent labor induction, those with a CD without labor were older, were more likely to be married and have private insurance, and had higher rates of diabetes mellitus and hypertensive disorders (–Table 1).

In both unadjusted and adjusted analyses, the rates of composite maternal morbidity did not differ following a CD without labor compared to labor induction (aOR = 2.14, 95% CI: 0.64–7.13). The model fit was adequate (Hosmer–Lemeshow $p=0.46$). The components of the composite maternal morbidity did not differ between groups, including infectious morbidity, hemorrhagic morbidity, and venous thromboembolism. The rate of composite neonatal morbidity did not differ between groups as well: Hosmer–Lemeshow $p=0.87$; aOR = 3.62, 95% CI: 0.42–31.19 (–Table 2).

A subgroup analysis comparing CD without labor and those with indicated CD following induction ($N=140$) is described in –Table 3. No differences were demonstrated between the groups. A different subgroup analysis comparing CD without labor versus labor induction among patients with a BMI of ≥ 50 kg/m² also showed similar maternal and neonatal outcome rates between groups (–Supplementary Table S1 [available in the online version only]).

Discussion

Nulliparous individuals with class III obesity at term did not have different short-term maternal or neonatal outcomes whether they underwent IOL or CD without labor. Outcomes also did not differ between those who underwent CD without labor and indicated CD following induction. The rate of indicated CD among those who underwent IOL was relatively high (56.0%).

Our study supports prior reports of high CD rates among nulliparas at term with class III obesity undergoing labor induction.^{12,13} Moreover, according to a previous study, 46% of induced nulliparous individuals at term with class III obesity met the criteria for failed induction.^{17,19}

Subramaniam et al had previously compared CD without labor versus IOL among patients with class III obesity ($n=661$) in a retrospective cohort study.¹⁴ They included both parous and nulliparous singletons who delivered at term (≥ 37 weeks), excluding patients in spontaneous labor and fetal anomalies. The primary outcome was a composite of maternal morbidity, including operative, infectious, and thromboembolic complications. The secondary outcome was a neonatal composite. Their results are consistent with our study, showing that the composite maternal and neonatal outcomes did not differ.¹⁴

A previous retrospective cohort study, conducted by Homer et al ($n=591$), compared the outcomes of planned

Table 1 Demographic and clinical characteristics

| Characteristics | Induction (N = 250) | CD without labor (N = 58) | p-Value |
|--|---------------------|---------------------------|------------------|
| Maternal age (y) | | | 0.001 |
| < 20 | 24 (9.6) | 1 (1.7) | |
| 20–34 | 198 (79.2) | 40 (69.0) | |
| ≥ 35 | 28 (11.2) | 17 (29.3) | |
| Race/ethnicity | | | 0.95 |
| White | 51 (20.4) | 11 (19.0) | |
| Black | 118 (47.2) | 26 (44.8) | |
| Hispanic | 48 (19.2) | 13 (22.4) | |
| Other | 33 (13.2) | 8 (13.8) | |
| Marital status | | | 0.03 |
| Single | 155 (62.0) | 24 (41.4) | |
| Married | 87 (34.8) | 30 (51.7) | |
| Separated/widowed | 1 (0.4) | 1 (1.7) | |
| Unknown | 7 (2.8) | 3 (5.2) | |
| Private insurance | 110 (44.0) | 36 (62.1) | 0.01 |
| Smoking during pregnancy | 7 (2.8) | 2 (3.4) | 0.68 |
| Body mass index at delivery (kg/m ²) | | | 0.67 |
| 40–49.9 | 196 (78.4) | 44 (75.9) | |
| ≥ 50 | 54 (21.6) | 14 (24.1) | |
| Diabetes mellitus | 41 (16.4) | 17 (29.3) | 0.02 |
| Hypertensive disorders | 172 (68.8) | 23 (39.7) | <0.001 |
| Postterm (≥40.0 wk) | 42 (16.8) | 4 (6.9) | 0.07 |

Abbreviation: CD, cesarean delivery.

Note: Data are presented as N (%).

Table 2 Labor induction versus cesarean delivery without labor and maternal and neonatal outcomes

| Outcomes | Induction (N = 250) | CD without labor (N = 58) | Unadjusted OR (95% CI) | Adjusted OR ^a (95% CI) |
|-----------------------------------|---------------------|---------------------------|------------------------|-----------------------------------|
| Composite maternal outcome | 11 (4.4) | 5 (8.6) | 2.05 (0.68–6.15) | 2.14 (0.64–7.13) |
| Infectious morbidity | 4 (1.6) | 1 (1.7) | 1.08 (0.12–9.84) | 0.91 (0.09–9.52) |
| Surgical site infection | 2 (0.8) | 1 (1.7) | – | – |
| Endometritis | 2 (0.8) | 0 | – | – |
| Hemorrhagic morbidity | 9 (3.6) | 3 (5.2) | 1.46 (0.38–5.57) | 1.59 (0.38–6.72) |
| Transfusion | 5 (2.0) | 3 (5.2) | 2.67 (0.62–11.52) | 3.44 (0.70–17.00) |
| Mechanical tamponade ^b | 3 (1.2) | 0 | – | – |
| Surgical tamponade ^c | 4 (1.6) | 0 | – | – |
| Hysterectomy | 0 | 0 | – | – |
| Venous thromboembolism | 0 | 0 | – | – |
| ICU admission | 1 (0.4) | 2 (3.4) | – | – |
| Maternal death | 0 | 0 | – | – |
| Composite neonatal outcome | 2 (0.8) | 2 (3.4) | 4.43 (0.61–32.12) | 3.62 (0.42–31.19) |
| Ventilation >6 hours | 0 | 1 (1.7) | – | – |
| Seizures | 0 | 0 | – | – |
| Sepsis | 1 (0.4) | 0 | – | – |
| Meconium aspiration syn. | 0 | 0 | – | – |

(Continued)

Table 2 (Continued)

| Outcomes | Induction (N = 250) | CD without labor (N = 58) | Unadjusted OR (95% CI) | Adjusted OR ^a (95% CI) |
|-----------------------|------------------------|------------------------------|---------------------------|--------------------------------------|
| Brachial plexus palsy | 1 (0.4) | 1 (1.7) | – | – |
| HIE | 0 | 0 | – | – |
| Neonatal death | 0 | 0 | – | – |

Abbreviations: CD, cesarean delivery; CI, confidence interval; ICU, intensive care unit; HIE, hypoxic–ischemic encephalopathy; OR, odds ratio.
Notes: Data are presented as N (%).

The goodness-of-fit assessment for both composite outcomes was adequate (Hosmer–Lemeshow $p = 0.46$ for the maternal outcome; $p = 0.87$ for the neonatal outcome).

^aOutcomes were adjusted for maternal age and hypertensive disorders.

^bA recorded use of a Bakri balloon tamponade for postpartum hemorrhage.

^cAny of the following procedures in the context of postpartum hemorrhage: O'Leary, B-Lynch, uterine artery embolization.

Table 3 Indicated versus cesarean delivery without labor and maternal and neonatal outcomes

| Outcomes | Indicated CD (N = 140) | CD without labor (N = 58) | Unadjusted OR (95% CI) | Adjusted OR ^a (95% CI) |
|-----------------------------------|---------------------------|------------------------------|---------------------------|--------------------------------------|
| Composite maternal outcome | 9 (6.4) | 5 (8.6) | 1.37 (0.44–4.29) | 1.80 (0.51–6.29) |
| Infectious morbidity | 4 (2.9) | 1 (1.7) | 0.60 (0.07–5.45) | 0.63 (0.06–6.47) |
| Surgical site infection | 2 (1.4) | 1 (1.7) | – | – |
| Endometritis | 2 (1.4) | 0 | – | – |
| Hemorrhagic morbidity | 7 (5.0) | 3 (5.2) | 1.04 (0.26–4.15) | 1.39 (0.31–6.18) |
| Transfusion | 4 (2.9) | 3 (5.2) | 1.85 (0.40–8.56) | 2.55 (0.49–13.20) |
| Mechanical tamponade ^b | 2 (1.4) | 0 | – | – |
| Surgical tamponade ^c | 4 (2.9) | 0 | – | – |
| Hysterectomy | 0 | 0 | – | – |
| Venous thromboembolism | 0 | 0 | – | – |
| ICU admission | 1 (0.7) | 2 (3.4) | – | – |
| Maternal death | 0 | 0 | – | – |
| Composite neonatal outcome | 0 | 2 (3.4) | – | – |
| Ventilation >6 hours | 0 | 1 (1.7) | – | – |
| Seizures | 0 | 0 | – | – |
| Sepsis | 0 | 0 | – | – |
| Meconium aspiration syn. | 0 | 0 | – | – |
| Brachial plexus palsy | 0 | 1 (1.7) | – | – |
| HIE | 0 | 0 | – | – |
| Neonatal death | 0 | 0 | – | – |

Abbreviations: CD, cesarean delivery; CI, confidence interval; ICU, intensive care unit; HIE, hypoxic–ischemic encephalopathy; OR, odds ratio.
Note: Data are presented as N (%).

^aOutcomes were adjusted for maternal age and hypertensive disorders.

^bA recorded use of a Bakri balloon tamponade for postpartum hemorrhage.

^cAny of the following procedures in the context of postpartum hemorrhage: O'Leary, B-Lynch, uterine artery embolization.

vaginal delivery versus CD without labor among patients with a BMI of $\geq 50 \text{ kg/m}^2$.¹⁸ They included both parous and nulliparous patients who delivered at ≥ 24 weeks. Similar to our results, this study reported no significant differences in anesthetic, postnatal, or neonatal complications between groups, with the exception of shoulder dystocia (3 vs. 0%, $p = 0.02$). Of note, the planned vaginal group included patients with spontaneous labor. Another prior large study showed that class III obesity was associated with an increased risk of adverse neonatal outcomes. However, no

difference was noted between planned CD and labor induction.²⁰

Individuals with class III obesity are at increased risk of a prolonged pregnancy and have an increased rate of labor induction.⁹ More than half of the nulliparas in this population undergoing IOL will eventually have a CD.^{12,13} Furthermore, previous data suggest that patients with indicated CD following IOL have higher rates of adverse outcomes than those with successful IOL.^{12–14} Our study shows that patients who underwent a CD without labor had similar short-term

maternal and neonatal outcomes as those who underwent IOL. This finding might influence counseling for nulliparas at term with class III obesity when discussing mode of labor.

Identifying patients who will benefit from a CD without labor instead of IOL might improve the decision-making process for the mode of delivery of nulliparous patients with class III obesity. All existing studies dealing with this issue, including this one, were retrospective, largely single-centered, and did not have large cohorts. In addition, as stated above, the inclusion criteria of previous studies were not homogenous, including either parous patients or those with spontaneous labor.^{14,18} The accumulating data on this matter suggest that a large multicentered observational study might be in order, or, ideally, an interventional one.

Strengths and Limitations

This study has several strengths. It concerns an understudied issue, with a growing interest, as both increased BMI and induction rates are on the rise.^{2,6} The data arising from the study are not contradictory to previous research, although the preferred mode of delivery for this population remains unknown. This study focused on nulliparous patients undergoing induction, a subgroup with a relatively high risk of indicated CD. Furthermore, the indications for CD were available.

Limitations of this study should be acknowledged, including its retrospective nature with the accompanying inherent biases. A selection bias exists, as many individuals who underwent a CD without labor were not candidates for a trial of labor. However, the fact that they are all nulliparous minimizes this bias. Some differences were found in the baseline characteristics between the groups, potentially affecting results. Nonetheless, we controlled for possible confounders in a logistic regression analysis. Due to our inclusion criteria, our sample size is limited, possibly increasing the risk of a type II error.

Conclusion

Among nulliparous individuals with class III obesity at term who underwent induction, more than half had indicated CD; short-term maternal and neonatal morbidity rates, however, did not differ between labor induction and CD without labor.

Funding

None.

Conflict of Interest

None declared.

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