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OBSTETRICS AND GYNECOLOGY RESEARCH

ISSN: 2637-4560

Research Article

# Decision-To-Delivery Interval in Obese Patients Undergoing Emergent Cesarean Birth

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## Abstract

**Objective:** To examine how increased body mass index (BMI) class impacts time to delivery interval in the setting of emergent cesarean birth.

**Study Design:** A cohort study of all emergent cesarean births at our institution from 2012-2018. Three comparison groups were divided by BMI category:

1. Non obese; </=30 kg/cm$^2$ (n=55)

2. Class I obesity; 31-34 kg/cm$^2$ (n=75)

3. Class II and III Obesity; >/=35 kg/cm$^2$ (n=51)

Primary outcomes were time interval from decision-to-delivery interval and from skin-incision-to-delivery interval.

**Results:** The mean time interval (minutes +/- standard deviation (SD)) from arrival at the OR to delivery was 25.1 ± 9.7, 26.1 ± 10.6 and 30.2 ±12.2, highlighting that as patient BMI class increased, the interval time to arrival to the OR and to delivery increased (beta coefficient 95% CI 5.15 (1.01,9,30) p=0.037). The mean time interval (minutes +/- SD) from skin incision to delivery was 8.7 ± 5.6, 9.0 ± 6.4 and 11.7 ±7.0, again showing a positive correlation between time interval and increasing BMI class (beta coefficient 95% CI 3.02 (0.65,5.40) p=0.025).

**Conclusion:** This study describes the challenge of urgent cesarean births in obese patients, manifested in longer decision-to-delivery and skin-to-delivery intervals as BMI class increases. These findings support prior literature that describe a longer transport and surgical times in obese patients undergoing cesarean birth.

**Keywords:** Category II Fetal Heart Rate Tracing; Non-Reassuring Fetal Heart Rate; Obesity; Obesity in Pregnancy; Urgent Cesarean birth

## Introduction

Cesarean birth (CB) is the most common surgical procedure in the US with over 1 million CB performed every year. Alongside increasing rates of CB around the country, the US is also experiencing an obesity epidemic, where over 40 percent of US women are overweight or obese[1]. Obesity has been correlated with worse obstetrical outcomes in this patient population including higher rates of labor dystocia and CB, higher rates of maternal hypertensive disease and diabetes (both gestational and pregestational) as well as higher rates of wound infections, dehiscence and breakdown [2]. Massive obesity (weight over 300 lbs) is associated with increase in operative

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**Citation:** Itamar D. Futterman, Liel Navi, Hae-Young Kim, Roni Mendonca, Michael Girshin, Alexander Shilkrut. Decision-To-Delivery Interval in Obese Patients Undergoing Emergent Cesarean Birth. Obstetrics and Gynecology Research 5 (2022): 219-224.

**Received:** September 05, 2022
**Accepted:** September 12, 2022
**Published:** September 27, 2022

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DOI:10.26502/ogr095

time, increased blood loss, epidural placement failure, endometritis, and prolonged hospitalization[2]. In addition to increased risk of cardiovascular disease, hypertension and diabetes, obesity increased the risk of CB. In women with Class III obesity who underwent labor induction, the CB rate approaches 50 percent [3]. The National Institute of Child Health and Human Development divides fetal heart tracing into three distinct categories I, II, III. In the setting of Category I tracing, labor may continue, Cat III requires emergency CB. During the labor course, there is often need to perform urgent and emergency CB due to category II or III tracing not responding to resuscitative measures. Outcomes for these deliveries have been described previously[4]. In these situations, the expeditious delivery of the fetus is of utmost importance, yet time intervals to delivery of the fetus in patients with varying BMIs, has been insufficiently described in the literature. The significance of the length of time from clinical decision making to execution in the context of obstetrical emergencies has been a topic of focus in recent years and is continuously revisited by the American College of Obstetrics and Gynecology (ACOG)[5]. ACOG addresses the fact that obstetrical emergencies can happen at any time. The familiarity with these emergencies, as well as ongoing preparations for them in the form of simulations, is key for successful management to minimize maternal and neonatal mortality and morbidity[5].

The neonate born to an obese mother carries a risk of morbidity and mortality described previously[6]. Knowing this risk exist, it is critical to describe the expected time intervals needed to perform an emergent CB in attempts to minimize neonatal morbidity in a newborn whose baseline risk of adverse outcomes is high, merely by the fact that it is born to an obese mother.

The purpose of this study is to provide the obstetrician better understanding of the average times required to perform urgent CB in obese patients compared with non-obese patients, while also commenting on the associated neonatal morbidity of neonates born to obese mothers.

## Methods

A retrospective cohort study of all emergent cesarean births occurring at our institution from 2012-2018. Institutional Review Board approval was given through BRANY # 19-12-429-182. IRB waived the need for informed consent. Data was collected by initially identifying all cesarean births by query of our electronic medical record (EMR) in our institution in the time frame specified above. Next, we identified all those who had documentation indicating an emergent cesarean for fetal indications including: category II/III fetal heart rate tracing, fetal bradycardia, placental abruption or umbilical cord prolapse. Of those births, we then stratified these births by maternal BMI class.

Three comparison groups were divided and their outcomes comapred by BMI class: [1]. Non-obese with BMI </=30 kg/cm$^2$, [2]. Class I Obesity with BMI of 31-34 kg/cm$^2$, and [3]. Class II and III obesity with BMI >/=35 kg/cm$^2$. There were no BMI minimums or maximums for inclusion or exclusion. The primary outcomes were the time-interval from arrival to the operating room (OR) to delivery, and from skin incision to delivery. Times were recorded by the primary nurse caring for the patient. Secondary outcomes were a measure of neonatal morbidities: 5-minute Apgar score less than 7, umbilical cord arterial pH (arterial cord pH <7.2), and NICU admissions.

Inclusion Criteria: All singleton, non-anomalous pregnancies, who delivered beyond 37 weeks of gestation at our institution from 2012-2018 via urgent and emergency CB. Indications for CB included: category II/III fetal heart rate tracing, fetal bradycardia, placental abruption or umbilical cord prolapse. Exclusion criteria included multi-fetal gestations, cesarean birth secondary to other indications such as fetal malpresentation, maternal hypertensive disease, failed inductions or arrest of labor and those delivered prior to 37 weeks of gestation.

Continuous variables were summarized as means and standard deviations (SD). For variables that were not normally distributed, median and interquartile ranges were used. Categorical variables were summarized as percentages. Kruskal-Wallis Test was used for continuous variable and Fisher's exact test was used for the categorical variable to test differences between groups. The primary outcomes and arterial cord pH were considered continuous outcomes. Apgar score and NICU admission were considered as the binary outcomes. For the continuous outcomes, the linear regression models were used to compare the means between groups after adjusting for maternal age and number of prior laparotomies. For the outcome variables that were not normally distributed, log-transformation was used to reduce skewness. Logistic regression models were used after adjusting for maternal age and number of prior laparotomies. A sub-group analysis was performed excluding those who underwent general anesthesia. Given previous literature that describes a direct correlation between lower APGAR scores and higher rates of fetal acidosis in those who underwent general anesthesia, we saw value in performing an analysis excluding this group of patients. Analyses was performed with SAS statistical software (9.4; SAS Institute, Cary, NC, USA). P-values <0.05 were considered to be statistically significant.

## Results

There were 55 patients in the non-obese cohort (BMI</=30 kg/cm$^2$), 75 in the class I obesity cohort (BMI=31-34 kg/cm$^2$), and 51 patients in the class II and III obesity cohort (BMI >/=35 kg/cm$^2$). Maternal demographics were collected

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DOI:10.26502/ogr095

and compared among the 3 groups and are summarized in (Table 1). The population served in our institution is largely homogenous, predominantly Hispanic with no, or government provided insurance.

Primary and secondary outcomes are summarized in (Table 2). The mean time interval (minutes +/- standard deviation (SD)) from arrival at the OR to delivery was 25.1 ± 9.7, 26.1 ± 10.6 and 30.2 ±12.2, highlighting that as patient BMI class increased, the interval time to arrival to the OR and to delivery increased (beta coefficient 95% CI 5.15 (1.01,9,30) p=0.037). The mean time interval (minutes +/- SD) from skin incision to delivery was 8.7 ± 5.6, 9.0 ± 6.4 and 11.7 ±7.0, again showing a positive correlation between time interval and increasing BMI class (beta coefficient 95% CI 3.02 (0.65,5.40) p=0.025). There were also higher rates of fetal acidosis in fetuses born to moms with a higher BMI class (beta coefficient 95% CI 0.03 (0.01, 0.06), p=0.047). We controlled for patient's age and number of prior laparotomies since there is evidence to suggest that these two factors can increase operative time and increase the baseline risk for cesarean birth.[7], [8]. A sub-group analysis was performed excluding patients who received general anesthesia. These findings are summarized in (Table 3). There was a statistically significant difference in the length of time from arrival in the OR to delivery, and from incision to delivery for patients with a higher BMI class, as well as higher rates of fetal acidosis (beta coefficient 95% CI 5.98 (1.98, 9.97) p=0.010, beta coefficient 95% CI 3.57 (1.10, 6.04), p=0.012), and beta coefficient 95% CI -0.03 (-0.07, -0.01), p=0.035 respectively).

## Discussion

Our findings are suggestive of prolonged both logistical and surgical time intervals, from the time the decision for emergent cesarean birth is made to delivery of the neonate

**Table 1:** Demographics

| Variable | | BMI </= 30 (N=55) | BMI 31-34 (N=75) | BMI >/=35 (N=51) | *P value |
|---|---|---|---|---|---|
| Maternal age† | | 30.1 ± 7.0 | 30.3 ± 7.4 | 30.3 ± 6.7 | 0.97 |
| Gestational age at delivery† | | 39.2 ± 2.8 | 38.7 ±2.7 | 38.5 ± 3.5 | 0.39 |
| Number Prior Laparotomies | 0 | 35 (63.6%) | 57 (76.0%) | 32 (62.7%) | 0.11 |
| | 1 | 18 (32.7%) | 13 (17.3%) | 18 (35.3%) | |
| | >/=2 | 2 (3.6%) | 5 (6.7%) | 1 (2.0%) | |
| Fetal Weight‡ | | 3260 (2990,3545) | 3100 (2655,3525) | 3248 (2815,3500) | 0.4 |

BMI- body mass index (kg/cm$^2$)
*Kruskal-Wallis Test for the continuous variable and Fisher's exact test for the categorical variables
†Reported in means ± SD
‡ Reported in median (IQR)

**Table 2:** Primary and Secondary Outcomes

| Variable | Non-obese (BMI </= 30) (N=55) | Class I obesity (BMI 31-34.9) (N=75) | Class II, III obesity (BMI >/=35) (N=51) | Beta Coefficient (95% CI) | P value* |
|---|---|---|---|---|---|
| Time of OR to Delivery (minutes) | 25.1 ± 9.7 | 26.1 ± 10.6 | 30.2 ±12.2 | 5.15 (1.01, 9.30) | 0.037 |
| Time of OR to Incision (minutes) | 16.4 ± 6.2 | 17.1 ± 7.0 | 18.5 ± 8.1 | 2.13 (-0.60, 4.85) | 0.293 |
| Time of Incision to Delivery (minutes) | 8.7 ± 5.6 | 9.0 ± 6.4 | 11.7 ±7.0 | 3.02 (0.65, 5.40) | 0.025 |
| Arterial Cord pH | 7.20 ± 0.10 | 7.22 ± 0.08 | 7.18 ± 0.11 | 0.03 (0.01, 0.06) | 0.047 |
| **Variable** | **Non-obese (BMI </= 29.9) (N=55)** | **Class I obesity (BMI 30-34.9) (N=75)** | **Class II, III obesity (BMI >/=35) (N=51)** | **OR (95% CI)** | **P value*** |
| NICU Admission | 30 (54.5%) | 43 (56.6%) | 28 (54.9%) | 1.01 (0.46, 2.22) | >0.99 |
| APGAR <7 (5 minutes of life) | 3 (5.5%) | 4 (5.3%) | 6 (11.8%) | 2.30 (0.53, 9.98) | 0.259 |

Results are reported in means ± Standard deviation
BMI- body mass index (kg/cm$^2$)
* Adjusted for Maternal Age and Number of Prior Laparotomies. Linear regression for the continuous outcome variables and logistic regression for the categorical outcome variables were used.

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DOI:10.26502/ogr095

**Table 3:** Subgroup Analysis: Outcomes Excluding Those Who Received General Anesthesia

| Variable | Non-obese (BMI </= 29.9) (N=48) | Class I obesity (BMI 30-34.9) (N=67) | Class II, III obesity (BMI >/=35) (N=45) | Beta Coefficient (95% CI) | P value* |
|---|---|---|---|---|---|
| Time of OR to Delivery (minutes) | 26.6 ± 8.9 | 28.0 ± 9.4 | 32.5 ± 10.9 | 5.98 (1.98, 9.97) | 0.01 |
| Time of OR to Incision (minutes) | 17.4 ± 5.8 | 18.2 ± 6.4 | 19.8 ± 7.6 | 2.41 (-0.30, 5.12) | 0.203 |
| Time of Incision to Delivery (minutes) | 9.2 ± 5.5 | 9.8 ± 6.2 | 12.7 ± 6.7 | 3.57 (1.10, 6.04) | 0.012 |
| Arterial Cord pH | 7.21 ± 0.08 | 7.22 ± 0.08 | 7.17 ± 0.11 | -0.03 (-0.07, -0.01) | 0.035 |
| **Variable** | **Non-obese (BMI </= 29.9) (N=48)** | **Class I obesity (BMI 30-34.9) (N=67)** | **Class II, III obesity (BMI >/=35) (N=45)** | **OR (95% CI)** | **P value*** |
| NICU Admission | 25 (52.1%) | 36 (53.7%) | 23 (51.1%) | 0.96 (0.42, 2.23) | 0.996 |
| APGAR <7 (5 minutes of life) | 1 (2.1%) | 2 (3.0%) | 4 (8.9%) | 4.26 (0.45, 40.8) | 0.235 |

Results are reported in means ± Standard deviation
BMI- body mass index (kg/cm2)
* Adjusted for Maternal Age and Number of Prior Laparotomies. Linear regression for the continuous outcome variables and logistic regression for the categorical outcome variables were used.

in obese patients, as well as lengthening of these intervals as BMI class increases. While the skin-to-delivery interval is likely to be affected by surgeon skills, maternal pannus and previous laparotomies, the time interval between arriving to the OR and skin incision is mainly affected by logistical perioperative preparation. These include: moving and positioning the patient on to the OR table, including additional OR staff to help position patients with larger BMIs, time to achieve adequate level of anesthesia and availability of equipment needed to perform both the anesthesia and obstetrical procedures. By controlling for number of prior laparotomies, we attempted to reduce the confounding factor of intra-abdominopelvic adhesive disease that could significantly delay the time interval from skin incision to delivery of the neonate. By doing so, we are able to present results that minimize this confounder, while understanding that the individual environment in which each CB took place will vary and controlling for number of providers available, timing of day at which the delivery took place and the level of the team's surgical expertise, were not available at time of data collection, and their significance could potentially be large. Furthermore, while prior cesareans are a risk factor for repeat CB, we wanted to include other laparotomies, as that number could potentially be more inclusive and indicative of potential abdominopelvic adhesive disease, a potential confounder of skin-to-delivery interval.

While prior studies have illustrated that increasing BMI is associated with longer total operative time and other measures of maternal surgical morbidity [9], [10]. Few have examined the impact that time interval from skin incision to delivery has on neonatal outcomes. To our knowledge, no prior studies have examined the effect of BMI has on these time intervals in the setting of emergent CB [11], [12]. Conner et al performed a retrospective cohort analysis with similar findings suggesting increasing BMI was associated with significantly increased time from skin incision to infant delivery [13]. The authors of that study state correctly that the results of any study evaluating incision-to-delivery interval and neonatal outcomes will inevitably be confounded by the indication to perform the surgery; CB tends to performed faster in cases where the fetus is suspected to be at risk [13]. In our study we analyzed the subgroup of patients who underwent urgent CB for non-reassuring fetal heart rate tracings where the stakes of timely delivery are higher, attempting to eliminate provider's bias on who needs faster surgery and who does not. Nevertheless, by the nature of the study design and the population studied, we could not eliminate baseline neonatal risk for morbidity in those born to obese mothers which has been described in the literature [4], [6].

As for neonatal outcomes, previous investigations have largely focused on women in labor, and the time interval from decision to perform cesarean to skin incision, or the interval from uterine incision to delivery, and the relationship to neonatal morbidity [11], [14], [15]. The measures of neonatal morbidity chosen in this study reflect relevant markers of clinical morbidity. An Apgar score less than 7 at 5 minutes has been associated with an increased risk for development of cerebral palsy (aOR 24.7-130.8 compared to Apgar score of 10 at 5 minutes) [16]. Umbilical cord arterial blood pH is a marker of neonatal acidosis as demonstrated in previous literature.[17]-[19].

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Our study offers several strengths. We analyzed a subgroup of patients who underwent cesarean births for non-reassuring fetal heart rate tracing, selecting a group where time-to-delivery is a critical part of the care compared to elective CB. Operative notes were independently reviewed by several investigators, and it was ascertained that all patients underwent urgent and emergent CB. EMR record reflected arrival to the OR time, skin incision time and delivery time of all patients undergoing CB, regardless of acuity limiting observer bias by the nursing team who records these times. Our institution holds a universal policy of umbilical cord blood collection at birth, which in turn reduces bias in evaluating fetuses with normal Apgar scores. Another strength of our study was exclusion of women who underwent general anesthesia in secondary analysis. By doing so, we were able to control for poor neonatal outcomes secondary to general anesthesia, previously recorded in the literature [20]. All data was collected from one institution that limits bias of different OR efficiencies and involves limited number of surgeons thus decreasing variation between surgical skills among different institutions.

Limitations of our study include a retrospective study design as well as a low number of patients, as we collected data from one institution. We had only few patients with BMI>40, so we could not isolate these patients into separate group, and this is the group that experiences highest delivery delay as well as highest morbidity. We used BMI class at the time of delivery, as this BMI is most highly associated with adverse outcomes.

## Conclusion

Our study found longer time intervals from arrival at the OR and from skin incision to infant delivery as BMI class increased, and a concomitant increase in neonatal morbidity for women undergoing emergent CB. Specifically, the time from arriving to the OR was approximately 5 minutes longer and time from skin incision to delivery 3 minutes longer for those with class II, III obesity compared to time intervals in non-obese women.

Category II tracing has been poorly defined and is open to interpretation allowing different intervals from diagnosis to delivery. Experts believe that in the setting of persistent Category II tracing, delivery should be executed in 1-2 hours.21 Preparing for delivery under these circumstances requires logistical planning to allow appropriate time from decision to delivery. With that in mind, additional time may be needed to in the setting of a category II or III FHRT in obese patients. As rates of obesity in the US continue to increase, care for obese pregnant patients requires meticulous planning. Understanding that CB in obese patients result in longer operative times and increased complications rates may impact perioperative planning and timely decision making.

## Statements and Declarations

## Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

## Competing Interests

The authors have no relevant financial or non-financial interests to disclose

## Ethics approval

This is an observational study. The BRANY Research Ethics Committee has confirmed that no ethical approval is required (IRB # BRANY # 19-12-429-182)

## Author Contribution

I Futterman: Protocol/project development, Manuscript writing/editing

L Navi: Protocol/project development, Data collection or management

H Y Kim: Data analysis

R Mendonca: Protocol/project development

M Girshin: Protocol/project development

A Shilkrut: Manuscript writing/editing

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