Impact of obesity on incision-to-delivery interval and neonatal outcomes at cesarean delivery

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OBJECTIVE: The purpose of this study was to test the hypothesis that increasing body mass index (BMI) is associated with increased time from skin incision to infant delivery and increased neonatal morbidity at cesarean delivery.

STUDY DESIGN: We performed a retrospective cohort study of all cesarean deliveries that occurred at 1 institution from 2004-2008. Four comparison groups were defined by BMI of <30 kg/m^2 (n = 668 women), 30-39.9 kg/m^2 (n = 1002 women), 40-49.9 kg/m^2 (n = 403 women), or ≥ 50 kg/m^2 (n = 193 women). The primary outcome was time from skin incision to infant delivery. Secondary outcomes were a composite measure of neonatal morbidity and its individual components: 5-minute Apgar score <7, umbilical cord arterial pH <7.10 and <7.20, umbilical cord arterial base excess ≤ 8 mmol/L, special care nursery admission, and neonatal intensive care unit admission.

RESULTS: Increasing BMI was associated with significantly increased time from skin incision to infant delivery, which demonstrated a dose-response pattern. Minutes from skin incision to delivery of the infant by BMI strata were 9.4 ± 5.9 for <30 kg/m^2, 11.0 ± 6.8 for 30-39.9 kg/m^2, 13.0 ± 8.0 for 40-49.9 kg/m^2, and 16.0 ± 11.3 for ≥ 50 kg/m^2 ($P < .01$). Composite neonatal morbidity was significantly higher with increasing BMI: 23.0% for <30 kg/m^2, 25% for 30-39.9 kg/m^2, 29.8% for 40-49.9 kg/m^2, and 32.1% for ≥ 50 kg/m^2 ($P = .02$).

CONCLUSION: Increasing BMI is associated with a significantly increased time from skin incision to infant delivery and neonatal morbidity. Cesarean delivery technique remains to be optimized for obese women.

Key words: cesarean delivery, incision, interval, neonatal outcome, obesity

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Rates of obesity and morbid obesity among obstetric patients in the United States are steadily increasing, creating an urgent need for evidence-based practices focused on this developing population.[1] Previous studies have demonstrated that obese women are at high risk for overall obstetric maternal morbidity that includes higher rates of cesarean delivery.[2,3] In addition, obese women are at remarkably increased risk for surgical-related morbidity after cesarean delivery; obese women have a higher rate of wound infection, wound separation, dehiscence, anesthetic complication, thrombosis, and surgical tissue injury that is associated with cesarean deliveries.[4-7] Surprisingly, there are little published data on the impact of obesity on cesarean surgical characteristics and neonatal outcomes.

In this study, we sought to evaluate the relationship between the length of time from cesarean skin incision to infant delivery and increasing body mass index (BMI). Secondarily, we aimed to establish whether there is a concomitant increase in neonatal morbidity with increasing BMI. Previous studies have investigated cesarean delivery decision to incision timing and the effect on neonatal outcome and have found conflicting results.[8-10] However, the impact of incision to delivery timing on neonatal morbidity, as it relates to obesity, remains unknown. We hypothesized that, as degree of obesity increases, time interval from skin incision to delivery is prolonged, with an associated increase rate of neonatal morbidity.

Materials and Methods

We performed a retrospective cohort study of all consecutive cesarean deliveries that were performed at one tertiary care facility over a 4-year study period from 2004-2008. Approval was obtained before the initiation of the study from the Washington University Human Research Protection Board. Inclusion criteria consisted of women with a nonanomalous, singleton gestation who underwent a cesarean delivery within the study period without regard to gestational age, indication for delivery, previous cesarean delivery, or labor before cesarean delivery. Exclusion criteria were met for women with multiple gestations or known fetal congenital anomalies.

Detailed demographic information on each patient was extracted from the medical record by dedicated obstetric

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TABLE 1
Baseline characteristics for women in the cohort compared by BMI

Characteristic	BMI, kg/m^2 <30 (n = 668)	30-39.9 (n = 1002)	40-49.9 (n = 403)	≥50 (n = 193)	*P* value
Age, y[a]	25.4 ± 6.5	26.0 ± 6.1	26.6 ± 6.3	27.9 ± 5.5	< .01
Nulliparity: 885 women, %	44.6	39.2	35.0	27.5	< .01
African American race: 1566 women, %	58.1	71.8	78.2	74.6	< .01
Tobacco use: 378 women, %	16.3	17.0	16.9	16.1	.98
Drug use: 185, %	8.4	8.8	7.4	5.7	.49
Diabetes mellitus: 203 women, %	3.9	8.3	16.4	19.7	< .01
Preeclampsia: 117 women, %	4.0	5.3	5.5	7.8	.21
Previous cesarean delivery: 973 women, %	38.0	42.7	45.4	56.0	< .01
Gestational age at delivery, wk[a]	38.7 ± 1.5	38.8 ± 1.4	38.7 ± 1.4	38.5 ± 1.3	.06
Birthweight g[a]	3130 ± 579	3299 ± 591	3356 ± 593	3339 ± 672	< .01
Indication for delivery because of nonreassuring fetal status: 658 women, %	30.1	29.4	30.0	21.2	.10
Labor before cesarean delivery: 1054 women, %	48.4	48.6	48.9	35.4	< .01
General anesthesia: 106 women, %	6.1	3.9	4.2	4.7	.19
Vertical skin incision: 83 women, %	2.3	1.8	5.0	15.5	< .01

BMI, body mass index.

[a] Data are given as mean ± SD.

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research nurses. Data that were obtained included patient medical and surgical history, obstetrics and gynecology history, prenatal history, antepartum records, delivery records, and postpartum records. BMI (kilograms per square meter) was calculated from the patient's height and weight that were recorded in the medical record at time of delivery; *obesity* was defined by the World Health Organization criteria to be a BMI of ≥30 kg/m^2.[11] Four study groups were defined by BMI; nonobese women (BMI, <30 kg/m^2) served as the reference group, and obese women were stratified into 3 comparison groups: BMI 30-39.9, 40-49.9, and ≥50 kg/m^2.

The primary outcome measure was time from skin incision to infant delivery. This interval was defined as the minutes that elapsed from initial skin incision to complete delivery of the infant. Time was recorded routinely in the medical chart by the nurse in the operating room and was available for all patients in the cohort.

Secondary outcomes were composite neonatal morbidity and its individual components. Measures of neonatal morbidity included 5-minute Apgar score <7, umbilical cord arterial pH <7.10 and <7.20, umbilical cord arterial base excess ≤8 mmol/L, special care nursery (SCN) admission, or neonatal intensive care unit admission. Infants with ≥1 marker of morbidity were considered positive for neonatal composite morbidity; infants with ≥1 criterion for neonatal morbidity were counted only once in the composite. Apgar scores were assigned clinically by the attending physician or nurse practitioner attending the delivery.[12] Umbilical arterial blood gases universally were obtained immediately after delivery from an umbilical cord segment. The individual components of the composite outcome were chosen for their clinical relevance. For analysis of the secondary outcomes, women who received general endotracheal anesthesia were excluded from analysis to decrease bias, given the a priori increase in risk for the measures of adverse outcomes among women who undergo general anesthesia.

Baseline characteristics were compared between the study groups with the use of 1-way analysis of variance for continuous variables and χ^2 test for categoric variables. Normal distribution of continuous variables was tested by examination of the histogram and the Kolmogorov-Smirnov test. The primary outcome (incision to delivery interval) was compared between groups with the use of 1-way analysis of variance with Tukey post-hoc analysis and with test of trend. Bivariate analyses were then performed to identify potentially confounding variables. Because the primary outcome measure is a continuous variable, we used multiple linear regression analysis to model its independent relationship with increasing BMI while controlling for confounders. Candidate variables were obtained from results of our bivariate analyses, biologic plausibility, and variables that had been