OBSTETRICS

The relationship between primary cesarean delivery skin incision type and wound complications in women with morbid obesity

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OBJECTIVE: We sought to evaluate the relationship between skin incision, transverse or vertical, and the development of wound complications in women with morbid obesity requiring primary cesarean delivery (CD).

STUDY DESIGN: Morbidly obese women (body mass index $\geq$40 kg/m^2) undergoing primary CD at $\geq$24 weeks' gestation were studied in a secondary analysis of a multicenter registry. Clinical characteristics and outcomes were compared between women who had transverse vs vertical skin incision. The primary outcome was composite wound complication (infection, seroma, hematoma, evisceration, fascial dehiscence) and composite adverse maternal outcome (transfusion, hysterectomy, organ injury, coagulopathy, thromboembolic event, pulmonary edema, death). Multivariable logistic regression analyses were performed to adjust for confounding factors.

RESULTS: In all, 3200 women were studied: 2603 (81%) had a transverse incision and 597 (19%) had a vertical incision. Vertical skin incision was associated with lower risk for wound complications (adjusted odds ratio, 0.32; 95% confidence interval, 0.17—0.62; $P < .001$) but not with composite adverse maternal outcome (adjusted odds ratio, 0.72; 95% confidence interval, 0.41—1.25; $P = .24$).

CONCLUSION: In morbidly obese women undergoing a primary CD, vertical skin incision was associated with a lower wound complication rate. Due to the selection bias associated with utilization of skin incision type and the observational nature of this study, a randomized controlled trial is necessary to answer this clinical question.

Key words: cesarean delivery, morbid obesity, obesity, skin incision, wound complication

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Cesarean delivery (CD) is a common surgical procedure, responsible for 31.3% of US births in 2011.[1] It is on the rise: the CD rate increased by nearly 60% from 1996 through 2009.[2] In addition, the prevalence of adult obesity is high, 36% in the United States in 2009 through 2010.[3] A recent systematic review of 11 cohort studies reported that the risk of CD increased by 50% in women with a body mass index (BMI) of 30-35 kg/m^2 and more than doubled in women with a BMI >35 kg/m^2 compared to women with a normal BMI.[4] The frequency of wound complications following CD ranges from 3-17%[5-10]; however, in women with morbid obesity it is as high as 30%.[11] Finally, wound complications are a burden for the patient, her family, and the health care system; 1 study estimated that a postdischarge wound complication on average costs an additional $\geq$$3000.[12]

There are no randomized clinical trials comparing the risks and benefits of skin incision type (vertical or transverse) for CD in obese women. Current practice is largely based on surgeon or institutional preference. For reasons of aesthetics and postoperative pain, transverse incision is generally favored for the normal weight woman undergoing a nonemergent CD. However, the optimal skin incision type for the morbidly obese woman is unknown. With a transverse incision, there is concern for poor wound healing due to the incision being covered by a large panniculus with greater exposure to microbial flora and low oxygen tension. On the other hand, a vertical incision could theoretically heal poorly due to a longer incision, a deeper subcutaneous layer and because of more wound tension. The objective of our study was to determine which type of skin incision was associated with a lower wound complication rate in morbidly obese women undergoing primary CD.

Materials and Methods

Study design

This was a secondary analysis of a multicenter cesarean registry of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Maternal-Fetal Medicine

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Units Network conducted from 1999 through 2002 at 19 academic medical centers.

Our analysis focused on a cohort of morbidly obese (BMI $\geq$40 kg/m^2) women with gestational age $\geq$24 weeks who had primary CD. Exclusion criteria were stillbirth and unknown skin incision type. Clinical characteristics and outcomes were compared between women who had a transverse or vertical skin incision.

The labor and delivery logbook or database at each participating center was screened daily to identify all cases. Trained study nurses who were not blinded to the mode of delivery reviewed the medical records for each woman and infant. Demographic data, details of the obstetrical history, and information about intrapartum and postpartum events until time of discharge plus any readmissions until 6 weeks' postpartum were recorded. Emergency room and outpatient records were not reviewed. If the patient was known to have been readmitted at an outside facility, attempt was made to obtain those records for review. Neonatal data were collected up to 120 days after delivery or at the time of hospital discharge.

Uniform definitions were established at the study design. The same definitions were followed at the 19 centers and prospectively reviewed at time of collection, and data clarification was established by direct communication with the providers.

BMI data were obtained as prepregnancy BMI as well as BMI at delivery. For the purpose of our study, BMI at delivery was used for inclusion and statistical analysis. A list of indications for CD, as well as type with skin incision description, was determined at the study design. Derived maternal complication variables including infectious complications were also well defined prior to data collection. Full details of the study design and technique of data collection have been previously described.[13]

Outcomes analyzed

The primary outcome was a composite of wound complications: infection, seroma, hematoma, wound evisceration, and fascial dehiscence. Secondary outcomes included a composite of maternal complications: blood transfusion, hysterectomy, organ injury, coagulopathy, thromboembolic event, pulmonary edema, and death. Length of surgery, maternal intensive care unit admission, and organ injury including cystotomy, bowel injury, as well as ureteral injury were also evaluated.

Statistical analysis

Statistical analysis was performed with software (SPSS, version 20.0; IBM Corp, Armonk, NY). Maternal demographics, clinical characteristics, and outcomes were described and compared between study groups (transverse skin incision vs vertical skin incision) using χ^2, Student t test, and Mann Whitney U test as appropriate. Multivariable analyses were performed using logistic regression for the development of wound complications, maternal adverse composite outcome, and vertical skin incision. The model was constructed using independent variables with clinical significance or those that had $P < .25$ on univariate comparison. Nominal 2-sided P values are reported with statistical significance defined as $P < .05$. The study was submitted to the University of Texas Institutional Review Board and considered exempt.

Results

A total of 3200 women met study criteria: 2603 (81%) had transverse incisions and 597 (19%) had vertical incisions. Table 1 compares the

TABLE 1
Comparison of demographic and clinical characteristics

Characteristic	Transverse skin incision (n = 2603)	Vertical skin incision (n = 597)	*P* value
Age, y	26.9 ± 6.3	26.9 ± 6.3	.78
Race			< .001
Black	1256 (48.3)	288 (48.2)	
White	1057 (40.6)	104 (17.4)	
Hispanic	218 (8.4)	188 (31.5)	
Other	72 (2.8)	17 (2.9)	
Maternal BMI, kg/m^2	45.3 ± 5.2	47.2 ± 6.4	< .001
Gestational diabetes	344 (13.2)	78 (13.1)	1.00
Pregestational diabetes	124 (4.8)	44 (7.4)	.01
Smoker	428 (16.0)	57 (13.0)	.02
Gestational age, wk	39.0 (37.0–40.4)	38.9 (36.4–40.4)	.20
Government or self-pay	1374 (52.8)	487 (81.6)	< .001
ASA score	2 (2–3)	2 (2–3)	.01
Singleton	2268 (87.0)	504 (84.4)	.08
Prophylactic antibiotics	2564 (74.0)	473 (85.0)	< .001
Chorioamnionitis	243 (9.0)	75 (13.0)	.02
Laboring prior to cesarean	1991 (76)	438 (74)	.15
Emergency cesarean	343 (13.0)	139 (23.0)	< .001
Arrest disorder as indication	1041 (40.0)	206 (34.5)	.01
Low transverse hysterotomy	2489 (95.6)	492 (82.4)	< .001

Data expressed as n (%), mean ± SD, and median (interquartile range).

ASA, American Society of Anesthesiologists; *BMI*, body mass index.

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demographic and clinical characteristics between women based on skin incision type. After adjustments for confounding factors with logistic regression analysis, factors associated with performance of vertical skin incision were parity (adjusted odds ratio [aOR], 1.16; 95% confidence interval [CI], 1.09−1.25; $P < .001$), black race (aOR, 1.24; 95% CI, 1.03−1.51; $P = .03$), maternal BMI (aOR, 1.06; 95% CI, 1.04−1.08; $P < .001$), low transverse hysterotomy (aOR, 4.46; 95% CI, 3.21−6.20; $P < .001$), and emergent CD (aOR, 0.49; 95% CI, 0.39−0.62, $P < .001$).

Table 2 compares the frequency of complications based on skin incision type. Univariate comparisons indicated that women with a vertical skin incision had higher rates of wound complications, composite adverse maternal outcomes, endometritis, hysterectomy, and maternal intensive care unit admission. Table 3 describes the results of multivariable analysis for development of wound complications. Contrary to the findings in univariate analysis, after adjustment for confounding factors, vertical skin incision was associated with a lower risk for wound complications (aOR, 0.32; 95% CI, 0.17−0.62; $P = .004$). Other factors found to be independently associated with wound complications were maternal age, non-white race, maternal BMI, and American Society of Anesthesiologists score (Table 3). A separate logistic regression analysis was performed that indicated that vertical skin incision was not associated with development of the composite adverse maternal outcome (aOR, 0.72; 95% CI, 0.41−1.25; $P = .24$).

The majority of wound complications are due to infection, seromas, and hematoma compared to more serious conditions such as facial dehiscence or evisceration. To assess whether the skin incision type was associated with these more serious wound complications, we performed another logistic regression analysis. There was no association between skin incision type and development of facial dehiscence or evisceration (odds ratio [OR], 2.3; 95% CI, 0.8−6.7; $P = .15$).

TABLE 2
Comparison of outcomes

Outcome	Transverse skin incision (n = 2603)	Vertical skin incision (n = 597)	*P* value
Wound complication[a]	43 (1.7)	25 (4.2)	< .001
Infection	31 (1.2)	17 (2.8)	
Seroma	12 (0.5)	11 (1.8)	
Hematoma	9 (0.3)	2 (0.3)	
Wound evisceration	1 (0.0)	3 (0.5)	
Fascial dehiscence	8 (0.3)	6 (1.0)	
Composite adverse maternal outcome	76 (2.9)	30 (5.0)	.02
Endometritis	253 (10)	82 (14)	.01
ICU admission	19 (1.0)	11 (2.0)	.02
Hysterectomy	6 (0.2)	5 (0.8)	.04
Transfusion	48 (1.8)	19 (3.2)	.06
Incision to delivery time, min	11.1 ± 6.1	9.2 ± 5.5	< .001

Data expressed as n (%) or mean ±SD.

ICU, intensive care unit.

[a] Some patients had >1 type of wound complication, as evidenced by the total number of wound complications being less than the sum of all subtypes of complications.

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COMMENT

To our knowledge, this is the largest study evaluating the association between skin incision type and wound complications after CD. The key findings of our study are as follows: (1) in univariate

TABLE 3
Multivariable logistic regression analysis for factors associated with wound complication

Factor	aOR (95% CI)	*P* value
Age	1.05 (1.00−1.10)	.04
Government or self-pay	1.04 (0.52−2.09)	.91
Smoker	1.13 (0.51−2.51)	.77
White race	0.48 (0.25−0.94)	.03
Diabetes (pregestational and gestational)	1.29 (0.64−2.63)	.48
Maternal BMI	1.05 (1.00−1.09)	.04
ASA score	2.10 (1.21−3.65)	.01
Intrapartum antibiotics	1.39 (0.69−2.78)	.35
Clinical chorioamnionitis	0.82 (0.31−2.16)	.68
Emergency cesarean delivery	0.82 (0.35−1.92)	.65
Vertical skin incision	0.32 (0.17−0.62)	.004
Low transverse hysterotomy	0.67 (0.24−1.90)	.45

aOR, adjusted odds ratio; *ASA*, American Society of Anesthesiologists; *BMI*, body mass index; *CI*, confidence interval.

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comparison, there was a higher rate of wound complications in the vertical skin incision group; (2) after multivariable logistic regression analysis, vertical skin incision was actually associated with a lower risk of wound complications; and (3) this discrepancy is most likely explained by selection bias. Given the differences in characteristics of women who had a vertical incision, surgeons may have chosen this route based on selected factors (ie, maternal diabetes, need for emergency CD, planned non-lower-segment CD); there are also center differences where institutional practices may drive more frequent use of vertical incisions for this patient group. Unfortunately, due to the registry nature of this study, we are unable to assess for center differences in our analysis.

There have been 4 studies evaluating skin incision type and CD wound complications.[5,10,11,14] Three were retrospective studies[5,11,14] and 1 was a prospective observational study,[10] with sample sizes ranging from 69-239 patients. Three of the 4 studies found no significance of skin incision type to wound complication rates,[10,11,14] and 1 found that vertical skin incision imposed a significant risk.[5]

The study of Alanis et al[11] offers the most relevant comparison to our findings due to similar study design. Its aim was to identify predictors of CD morbidity associated with massive obesity. It was a retrospective study of 194 morbidly obese women (BMI $\geq$50 kg/m^2) undergoing CD. The overall wound complication rate was 30%, of which 90% were wound disruptions. Only subcutaneous drains and smoking were found to be independently associated with wound complications. Vertical skin incision was not found to be associated with wound complications in their multivariable analysis with (OR, 3.4; 95% CI, 0.65−17.20) or without (OR, 1.4; 95% CI, 0.62−3.26) subcutaneous drains.

The strengths of our study include the number of women studied (n = 3200), which is substantially larger than other studies in the current literature. It also drew from 19 centers, making its finding potentially more applicable to a diverse population. In addition, we performed logistic regression analyses, which allowed us to adjust for some selection bias and confounding factors.

Limitations of our study include its observational nature as well as the limitations inherent in a registry-based analysis: the data were collected before we determined our research question, and therefore, not all data that might affect the outcome were available reliably in the registry, such as subcutaneous wound closure, skin closure techniques, preoperative hemoglobin values, and outpatient postpartum records. The latter is a significant limitation of our database: lack of postpartum patient records review undoubtedly leads to a falsely low wound complication rate in this high-risk population. Wound complication rates are reported as high as 30% in the morbidly obese,[11] while our composite wound complication rate was only 2.1%. Changes in practice since the time of data collection may also affect the significance of our findings. Cesarean prophylactic antibiotics have changed at some centers from a standard dose to doses based on BMI ranges. Additionally, prophylactic antibiotics timing has evolved from after cord clamp to prior to skin incision, which could theoretically alter infection rates. There has also been a shift away from prophylactic drain placement, as evidence has mounted against drains in prevention of wound complication.[15] Other limitations include the lack of defined protocol regarding which incision type would be used for a given patient, and the fact that there may be center-specific effects that we are unable to measure since outcomes by center are not described in the data set.

In summary, our findings emphasize the need for a randomized clinical trial to answer this important clinical question. Rising cesarean rates, rising obesity rates, the multifactorial nature of wound complications, and the burden of wound complications on the patient and the health care system stress the importance of such a study. ■

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