Wound Disruption Following Caesarean Delivery in Women With Class III Obesity: A Retrospective Observational Study

Yair Sagi, MD;[1] John Snelgrove, MD;[1] James Vernon, BSc;[2] Rohan D'Souza, MD;[1] Cynthia Maxwell, MD[1]

[1]Division of Maternal and Fetal Medicine, Department of Obstetrics and Gynaecology, Mount Sinai Hospital, University of Toronto, Toronto, ON

[2]Department of Social Science, University of Toronto, Toronto, ON

Abstract

Background: This study sought to identify risk factors associated with wound disruption following CS in women with class III obesity and to determine the value of individualized perioperative care plans in reducing its incidence.

Methods: The study included women with class III obesity who underwent CS after 24 weeks of gestation at Mount Sinai Hospital, Toronto, Ontario between 2011 and 2015 and collected data on demographics, clinical history, and perioperative details. Multivariable logistic regression analysis was performed to identify factors likely to contribute to a higher incidence of wound disruption (level of evidence II-3B).

Results: Of the 334 identified cases, in women with a mean BMI of 48.20 ± 7.52 kg/m^2, there were 60 cases of wound disruption (18%). The most common perioperative interventions involved Pfannenstiel skin incisions (75.6%), subcutaneous tissue closure (65.4%), use of pressure dressings (65%), and thromboprophylaxis (71.8%). On bivariable analysis, surgical time >1 hour (24.2% vs. 13.5%; OR 2.03; $P = 0.017$) and the use of thromboprophylaxis (20.1% vs. 10.6%; OR 2.22, $P = 0.031$) were associated with increased wound disruption, but these associations were attenuated on multivariable regression analysis.

Conclusions: No single risk factor or perioperative intervention was independently associated with wound disruption. However, the use of individualized perioperative care plans resulted in fewer wound disruptions in our cohort when compared with published literature.

Key Words: Obesity, Caesarean, surgical techniques, infections, surgical morbidity, wound disruption, pregnancy

Corresponding author: Dr. Cynthia Maxwell, Division of Maternal and Fetal Medicine, Department of Obstetrics and Gynaecology, Mount Sinai Hospital, Toronto, ON. cmaxwell@mtsinai.on.ca

Competing interests: See Acknowledgements.

Received on May 22, 2018

Revised on August 27, 2018

Résumé

Objectif : Cette étude avait pour but de déterminer les facteurs de risque associés à la déhiscence de la plaie de césarienne chez les femmes présentant une obésité de classe III et d'établir la valeur des plans de soins périopératoires personnalisés dans la réduction de son incidence.

Méthodologie : L'étude s'est penchée sur des femmes présentant une obésité de classe III ayant subi une césarienne après leur 24e semaine de grossesse à l'Hôpital Mount Sinai de Toronto (Ontario) entre 2011 et 2015. Des données sur les caractéristiques démographiques et les antécédents cliniques des femmes ainsi que des renseignements périopératoires ont été recueillis. Une analyse de régression logistique multivariée a été effectuée pour mettre en évidence les facteurs susceptibles de contribuer à une incidence accrue de la déhiscence de plaie (qualité des preuves II-3B).

Résultats : Parmi les 334 femmes incluses dans l'étude, dont l'IMC moyen était de $48{,}20 \pm 7{,}52$ kg/m^2, 60 (18 %) ont présenté une déhiscence de plaie. Les interventions périopératoires les plus courantes comprenaient la réalisation d'une incision de Pfannenstiel (75,6 %), la fermeture des tissus sous-cutanés (65,4 %), le recours à des pansements compressifs (65 %) et la thromboprophylaxie (71,8 %). L'analyse à deux variables a montré qu'un temps opératoire supérieur à une heure (24,2 % c. 13,5 %; RC : 2,03; $P = 0{,}017$) et la thromboprophylaxie (20,1 % c. 10,6 %; RC : 2,22; $P = 0{,}031$) étaient associés à des taux de déhiscence accrus; ces associations étaient toutefois moins fortes à l'analyse de régression logistique multivariée.

Conclusion : Aucun facteur de risque ou intervention périopératoire n'a été, à lui seul, indépendamment associé à la déhiscence. Toutefois, l'utilisation de plans de soins périopératoires personnalisés a donné lieu à un taux de déhiscence moindre au sein de cette cohorte, comparativement aux données publiées dans la littérature.

J Obstet Gynaecol Can 2018;000(000):1–7

https://doi.org/10.1016/j.jogc.2018.08.018

INTRODUCTION

Obesity, defined by the WHO as a body mass index (BMI) of 30 kg/m^2 and greater, is rising in incidence in both high- and middle-income countries and is a recognized global health problem.[1] In the United States, more than 50% of non-pregnant reproductive-aged women have overweight or obesity, and 8% are have extreme obesity defined as class III (BMI $\geq$40 kg/m^2), now reported as the fastest growing obesity class.[1–3] A systematic review of 11 cohort studies reported that the risk of CS increased by 50% in women with a BMI of 30 to 35 kg/m^2 and more than doubled in women with a BMI $>$35 kg/m^2 compared with women with a normal BMI.[4] Although the frequency of wound complications following Caesarean section (CS) ranges from 3% to 17% in the non-obese population,[5,6] studies have demonstrated a probable "dose-related" relationship between increasing obesity and post-CS wound disruption,[7–9] with an incidence as high as 30% in women with a BMI $>$50 kg/m^2.[10] Wound disruption is a burden not only for the patient, but also for her family and the health care system, with an additional cost of $3000 per case.[11]

Several modifications to surgical techniques have been proposed to lower the incidence of wound disruption in this population. These include modifications to the skin incision,[12–15] closure of the subcutaneous tissue,[16] prophylactic subcutaneous drains,[17,18] and negative pressure wound therapy dressings.[19] However, there is still no consensus on the best surgical techniques for reducing wound complications, and practice is often based on the preference and experience of the operating surgeon.[20] We hypothesized that individualized care plans that match aspects of the surgical technique to each patient could reduce wound disruption in women with class III obesity who were undergoing CS. The objectives of our study were to report our experience following the adoption of these care plans and to attempt to identify predictors of wound disruption in these women, with a view to making clinical practice recommendations.

METHODS

We collected retrospective data on women with class III obesity (BMI $>$40 kg/m^2) who underwent elective or emergency CS between 24 and 42 weeks of gestation at Mount Sinai Hospital, a tertiary referral centre in Toronto, Ontario, between January 2011 and December 2015. BMI was calculated from height and weight data collected during first antenatal booking visit. Patients with class III obesity are followed in a multidisciplinary "obesity in pregnancy clinic" led by a maternal-fetal medicine physician (C.M.). Obstetrics and gynaecology residents and MFM fellows attend this clinic as part of their clinical rotations. Each patient chosen to undergo an elective CS for any indication is assessed a few weeks before the procedure, both in left lateral and standing positions, and a care plan is drawn up with regard to various aspects of her perioperative care, including anaesthesia, antibiotics, choice of skin incision, method of skin closure, surgical dressing, venous thromboembolism prophylaxis, postoperative stay on a high-dependency unit, and plan for discharge. These care plans are influenced by a number of factors including the site of a previous CS scar, anticipated complexity of the procedure, presentation and weight of the fetus, number of fetuses, distribution of abdominal fat, the presence of a large overhanging panniculus, and preference of the patient. Transabdominal ultrasound is used in most cases to estimate abdominal wall subcutaneous thickness at the Pfannenstiel location, below the umbilicus and above the umbilicus, in an attempt to find the horizontal level of least thickness on the day of delivery. For emergency CSs, these decisions are made in conjunction with patients, by the attending MFM, according to their level of comfort with each aspect of the surgical procedure. All CSs were performed either by attending obstetricians or by residents and fellows under direct supervision of attending obstetricians.

Data on patient demographics (age, parity, education) and medical history (comorbidities, smoking status, prior wound infection) were collected from patient records. Information on CS included whether it was primary or repeat, elective or emergency, as well as the surgical time and timing of the day. The indication for CS, the surgical incision type (Pfannenstiel, high Pfannenstiel, transverse infraumbilical, vertical supraumbilical, midline infraumbilical), subcutaneous closure, closure of the skin (suture, staples), and wound dressing (adhesive tape, pressure dressing, NPWT dressing) were also collected. Subcutaneous closure, if performed, was with absorbable suture in all cases. Typical antibiotic prophylaxis during the study period was 2 g of cefazolin at the time of making the skin incision, except in a small number of cases, because of antibiotic allergy or physicians' preference.

On the basis of a literature review and expert opinion, we hypothesized a priori that the following variables could be associated with wound complications: BMI, CS booking

ABBREVIATIONS

MFM	maternal-fetal medicine
VTE	venous thromboembolism
NPWT	negative pressure wound therapy

Table 1. Characteristics of included patients (n = 334)

Age in years (mean, SD)	33.0 (5.2)
Nulliparous, n (%)	145 (43.4)
Number of fetuses, n (%)	
Singleton	312 (93.4)
Twins	21 (6.3)
Triplets	1 (0.3)
Ethnicity (n = 267)[a]	
White	200 (74.9)
Black	40 (15.0)
Asian	18 (6.7)
Hispanic	8 (3.0)
Mixed/other	1 (0.4)
Education (n = 143)[a]	
High school	45 (31.4)
College/university	98 (68.6)
Smokers, n (%)	29 (8.7)
Pre-pregnancy weight in kilograms (n = 312)*	126.3 (19.2) (90.71–210)
Blood pressure at first visit, mm Hg	
Systolic	127.9 (13.0)
Diastolic	77.8 (8.2)
BMI at first visit, kg/m^2	48.2 (7.5) (40–88.5)
Comorbidities, n (%)	
Hypertension	56 (16.8)
Pre-existing diabetes	33 (9.8)
Asthma	46 (13.8)
Obstructive sleep apnea	25 (7.5)
Hypothyroidism	53 (15.9)
Mental health conditions	4 (1.2)
Neurologic conditions	13 (3.9)
Hematologic (including thrombophilia)	14 (4.2)
Gastrointestinal disorders	10 (3.0)
Urinary tract disorders	2 (0.6)
Connective tissue diseases	4 (1.2)
None	162 (48.5)
Pregnancy complication (n = 334)	
Gestational diabetes mellitus	66(19.8)
Hypertensive disorders of pregnancy	40 (12.0)
Prior wound infection (n = 145; previous CS)[a]	8 (5.5)

[a] These data were self-reported and not routinely collected.

type (elective vs. emergency), skin incision site (Pfannenstiel vs. other types), subcutaneous layer closure, skin closure method, surgical time, and use of VTE prophylaxis. The primary outcome was a composite of wound complications: infection, seroma, hematoma, wound evisceration,

Table 2. Details of pregnancy and delivery

Indication for CS, n (%)	
Repeat elective CS	132 (39.5)[a]
Failure to progress in the first stage of labour	36 (11.1)
Failed labour induction	37 (10.8)
Non-reassuring fetal status	35 (10.5)
Fetal malpresentation	29 (8.7)
Multiple gestation	8 (2.4)
Suspected fetal macrosomia	8 (2.4)
Failure to progress in the second stage of labour	6 (1.8)
Maternal medical indications	6 (1.8)
Maternal request	6 (1.8)
Placenta praevia	3 (0.9)
Others	7 (2.1)
Anaesthesia (n = 334)	
Spinal	135 (40.4)
Epidural	124 (37.1)
Combined spinal-epidural	61 (18.2)
General	14 (4.2)
Preoperative hemoglobin (mean, SD)	117.4 (11.7)
Choice of antibiotic (n = 324)	
Cefazolin 1 g	46 (14.2)
Cefazolin 2 g	226 (69.7)
Cefazolin 3 g	4 (1.2)
Vancomycin	23 (7.0)
Clindamycin	13 (4.0)
Other	12 (3.7)
Type of incision (n = 326)	
Pfannenstiel	260 (79.7)
High Pfannenstiel	32 (9.8)
Transverse infraumbilical	19 (5.8)
Midline infraumbilical	11 (3.3)
Vertical supraumbilical	4 (1.2)
Use of Mobius retractor	69/320
Closure of subcutaneous layer	206/315
Skin closure (n = 333)	
Subcuticular suture	100 (30)
Staples	220 (66.0)
Mattress suture	10 (3.0)
Combination (mattress suture and staples)	3 (0.9)
Type of dressing (n = 331)	
Routine adhesive dressing	83 (25.0)
Pressure dressing	215 (64.9)
Negative pressure dressing	33 (9.9)
Deep venous thrombosis prophylaxis (n = 333)	
None	94 (28.2)

(*continued*)

Low-molecular-weight heparin	188 (56.4)
Unfractionated heparin	51 (15.3)
Postpartum hemorrhage	7/334
Blood transfusion	6/334
ICU admission	2/334
Hysterectomy	1/334

[a] 145 in Table 1 because some women had more than one CS.

dehiscence, and wound abscess. Secondary outcomes included a composite of maternal complications: blood transfusion, hysterectomy, postpartum hemorrhage, organ injury, coagulopathy, thromboembolic event, pulmonary edema, and death. Length of surgery, maternal ICU admission, and organ injury, including cystotomy, bowel injury, and ureteral injury, were also evaluated.

Summary statistics and frequencies were calculated for all variables. Bivariable analyses were conducted to examine the association between the dichotomized primary outcome (wound complication) and exposure variables of interest; we used chi-square tests for categorical variables and logistic regression for continuous variables. We then performed a multivariable logistic regression analysis, including all exposure variables of interest that were identified *a priori* and controlling for age. Analyses were performed using Stata software version 13.1 (StataCorp, College Station, TX).

Ethical approval for this study was obtained from the Research Ethics Board at Mount Sinai Hospital (REB#16-0115-C).

RESULTS

A total of 334 women met the eligibility criteria, and their characteristics are presented in Table 1. The mean first trimester BMI was 48.2 kg/m^2 (range 40−88.48 kg/m^2, SD 7.52). Almost one third of patients had medical comorbidities that pre-dated their pregnancy, the most common being chronic hypertension (16.76%), hypothyroidism (15.86%), asthma (13.77%), and pre-existing diabetes (9.8%). A further 19.8% developed gestational diabetes during pregnancy (Table 2). Although most women (312 of 334, 93.41%) had singleton pregnancies, there were 21 twin pregnancies and one triplet pregnancy. Of the 334 women, 145 (43.41%) had undergone previous CS, and eight (5.5%) of these women had experienced wound infections in the past.

Pregnancy and delivery details are presented in Table 2. With regard to the indications for CS, 163 were elective and 171 were emergency procedures. The most common indication for elective CS was a repeat CS (39.52%), whereas that for emergency CS was failure to progress in the first stage of labour (11.08%). Most (95.8%) women had some form of regional anaesthesia (spinal, epidural, or combined spinal-epidural), and most (84.1%) received cephalosporins as preoperative antibiotics. Women who were allergic or sensitive to cephalosporins or penicillins were given vancomycin, clindamycin, or other antibiotics at the discretion of the obstetrician. Although the most common type of skin incision (79.9%) was the Pfannenstiel incision, some women had higher incisions such as a high-Pfannenstiel (9.8%), transverse or midline infraumbilical (9.1%), or even a supraumbilical incision (5.8%). Subcutaneous skin closure, often in multiple layers, was documented in 206 of 315 (65.40%) cases. The skin was most often closed with staples (66%), but subcuticular skin closure was not uncommonly used (30%). Pressure dressings were used in 64.9%, NPWT dressings in 9.9%, and NPWT dressings and VTE prophylaxis in 71.7% of cases.

There were 60 cases of wound disruption (18%). By comparison, the institutional rate of wound disruption during this time period was 7% (internal communication). In addition to the aforementioned comorbidities, 11.9% of the women developed hypertensive disorders of pregnancy, and 19.7% developed gestational diabetes. Other major obstetric complications included postpartum hemorrhage (seven of 334; 2%); six of these women required blood transfusions, and one needed a hysterectomy because of postpartum hemorrhage not controlled by medical management and compression sutures. Two women required ICU admission—the first was a woman with chronic hypertension and asthma who developed pulmonary edema postoperatively, and the other had a case of severe wound infection resulting in a surgical abscess and subsequent sepsis. They both made good recoveries and were discharged from the ICU 2 and 7 days later, respectively.

Table 3 presents the results of bivariable and multivariable logistic regression analyses. Looking at crude ORs in the bivariable associations, surgical time $\geq$1 hour (24.2% vs. 13.5%; OR 2.03; $P = 0.017$) and the use of VTE prophylaxis (20.1% vs. 10.6%; OR 2.22; $P = 0.031$) were associated with a higher incidence of wound disruption. Although there was a higher incidence of wound disruption in women with a BMI $\geq$50 kg/m^2 compared with women with a BMI $<$50 kg/m^2 (22.5% vs. 15.1%; $P = 0.088$), and in women with comorbidities (20.3% vs. 11.8%; $P = 0.070$), these findings were not statistically significant. After adjusting for age and all variables of interest in the multivariable model, there was no evidence of

Table 3. Bivariable and multivariable logistic regression models

	Model No.	OR	SE	Lower 95% CI	Upper 95% CI	*P* value
Bivariable associations (varies by model)						
Maternal age (continuous, per year)	334	0.98	0.03	0.93	1.04	0.500
BMI $\geq$50 kg/m^2	334	1.63	0.47	0.93	2.86	0.090
Emergency CS	334	1.20	0.34	0.69	2.11	0.516
Repeat CS	334	0.84	0.24	0.48	1.49	0.556
Non-Pfannenstiel incision	326	0.95	0.08	0.80	1.13	0.566
Subcutaneous layer closure	334	0.99	0.01	0.98	1.01	0.403
Subcuticular skin closure	333	0.74	0.24	0.39	1.40	0.349
Surgical length $\geq$1 hour	312	2.03	0.61	1.13	3.65	0.017
VTE prophylaxis	333	2.22	0.82	1.08	4.59	0.031
Multivariable model 2[a]						
Maternal age (continuous, per year)	302	0.98	0.03	0.92	1.04	0.455
BMI $\geq$50 kg/m^2		1.47	0.47	0.78	2.76	0.231
Emergency CS		1.25	0.46	0.60	2.59	0.557
Repeat CS		0.94	0.35	0.45	1.95	0.873
Non-Pfannenstiel incision		0.99	0.40	0.45	2.18	0.990
Subcutaneous layer closure		1.00	0.01	0.98	1.02	0.846
Subcuticular skin closure		0.73	0.27	0.36	1.51	0.398
Surgical length $\geq$1 hour		1.88	0.60	1.00	3.52	0.050
VTE prophylaxis		1.64	0.66	0.74	3.62	0.222

[a] Adjusting for all variables listed in model.

statistically significant associations with the composite wound complication outcome. Specifically, associations between surgical length and VTE prophylaxis were attenuated.

DISCUSSION

No single perioperative intervention is independently associated with wound disruption in women with class III obesity. However, individualized care plans that take into account patients' characteristics, prior surgery, abdominal fat distribution, and other obstetric characteristics could result in a lower incidence of wound disruption than those reported in the literature.

Wound disruption following CS has major clinical and resource implications, and some studies have attempted to look at strategies that could reduce its incidence. With the traditional low transverse incision, there is concern regarding poor wound healing because of the size of the overhanging panniculus covering the incision, thus likely increasing wound exposure to microbial flora and low oxygen tension. Conversely, a vertical incision may heal poorly because of a longer incision, a deeper subcutaneous layer, and greater wound tension. Vertical skin incisions may be associated with higher wound complications in retrospective studies[12,13]; however, high transverse incisions have not been shown to reduce wound complications,[14,15] When it comes to incision type, there appears to be a strong preference among surgeons, with most surveyed surgeons preferring a Pfannenstiel incision for both non-emergency and emergency deliveries (84% vs. 66%), with or without taping the panniculus.[20] It is unlikely that the choice of a surgical incision for all women with class III obesity could be standardized without paying attention to characteristics such as the site of a previous incision, the distribution of abdominal fat, and surgeon preference.

There seems to be less controversy with regard to abdominal closure. Meta-analyses of techniques for subcutaneous closure at CS showed that in women with wound thickness greater than 2 cm, subcutaneous closure reduced wound disruption by 34%, with numbers needed to treat of 16,[16] but prophylactic subcutaneous drainage did not reduce the incidence of wound disruption, infection, hematomas, or seromas.[17] A multicentre RCT that randomized 280 women with obesity to subcutaneous suture re-approximation alone with suture plus subcutaneous drain also showed no

differences in the incidences of wound complications (17.4% vs. 22.7%) between groups.[18] The most recent systematic review, which included six RCTs and three cohort studies, suggested that the use of prophylactic NPWT dressings over standard dressings reduced the risk of surgical site infection in women with a BMI >30 kg/m^2 (adjusted risk ratio -6%; 95% CI -10.0% to -3.0%), with numbers needed to treat of 17.[19] However, just like with the choice of skin incision, it is important to consider individual patients' factors while making decisions with regard to abdominal closure.

Our incidence of wound disruption of 18% in women with a mean BMI of 48.2 kg/m^2 is less than reported in the literature (30%) in 194 pregnant women with a BMI >50 kg/m^2.[10] As shown by our regression analysis, this lower incidence could not be attributed to any single factor, but it may be the result of careful preoperative planning and the adoption of an individualized perioperative care bundle that comprised various aspects of perioperative care, including anaesthesia, antibiotics, surgical factors, VTE prophylaxis, and postoperative stay on a high-dependency unit.

Our choice of other predictor variables for wound disruption was based on literature review, as well as expert opinion. For example, it is known that there is racial variation in the relationships between BMI and body fat distribution,[21,22] body fat percentage,[22] and risk of disease.[23] Therefore, there is physiologic plausibility for racial discrepancies in CS wound complications among women with class III obesity. The association between surgical time >1 hour and the use of VTE prophylaxis that emerged on bivariable analysis was attenuated on multivariable regression analysis. It is possible that overadjustment could explain this effect attenuation; for example, surgical length is considered clinically when evaluating for the use of VTE prophylaxis. Our findings suggest these are potential risk factors; however, further research with larger sample sizes is warranted to clarify these relationships.

The strengths of our study are that, because our hospital is a regional referral centre, we had a relatively large sample size of ethnically diverse women with class III obesity, with a few women with a BMI of 80 kg/m^2 and above. We had good documentation of post-discharge follow-up. The weaknesses of our study include the retrospective study design, which can only point to associations between exposures and outcomes. Furthermore, some surgical aspects, such as uterine exteriorization at the time of uterine repair, were not consistently recorded in the health records and thus could not be incorporated into our multivariate analysis.

CONCLUSION

It is unlikely that any single perioperative factor or intervention will reduce the incidence of wound disruption in women with class III obesity or that any particular skin incision or technique of abdominal closure will be universally accepted or adopted in this patient population. However, with the use of individualized perioperative care plans, it may be possible to reduce the incidence of wound disruption in women with class III obesity.

Acknowledgements

Dr. D'Souza has received a New Investigator Grant from the Canadian Institutes for Health Research (CIHR) for an unrelated project on prevention of postpartum hemorrhage using tranexamic acid and a speaker's honorarium from Ferring Canada for a talk on induction of labour in pregnant women with obesity.

REFERENCES

1. Flegal KM, Carroll MD, Kit BK, et al. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. JAMA 2012;307:491–7.
2. D'Angelo D, Williams L, Morrow B, et al. Preconception and interconception health status of women who recently gave birth to a live-born infant—Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 26 reporting areas, 2004. MMWR Surveill Summ 2007;56:1–35.
3. Sturm R, Hattori A. Morbid obesity rates continue to rise rapidly in the United States. Int J Obes (Lond) 2013;37:889–91.
4. Poobalan AS, Aucott LS, Gurung T, et al. Obesity as an independent risk factor for elective and emergency caesarean delivery in nulliparous women—systematic review and meta-analysis of cohort studies. Obes Rev 2009;10:28–35.
5. Schneid-Kofman N, Sheiner E, Levy A, et al. Risk factors for wound infection following cesarean deliveries. Int J Gynaecol Obstet 2005;90:10–5.
6. Tran TS, Jamulitrat S, Chongsuvivatwong V, et al. Risk factors for postcesarean surgical site infection. Obstet Gynecol 2000;95:367–71.
7. Stamilio DM, Scifres CM. Extreme obesity and postcesarean maternal complications. Obstet Gynecol 2014;124:227–32.
8. Conner SN, Verticchio JC, Tuuli MG, et al. Maternal obesity and risk of postcesarean wound complications. Am J Perinatol 2014;31:299–304.
9. Myles TD, Gooch J, Santolaya J. Obesity as an independent risk factor for infectious morbidity in patients who undergo cesarean delivery. Obstet Gynecol 2002;100:959–64.
10. Alanis MC, Villers MS, Law TL, et al. Complications of cesarean delivery in the massively obese parturient. Am J Obstet Gynecol 2010;203:271.e1—7.
11. Perencevich EN, Sands KE, Cosgrove SE, et al. Health and economic impact of surgical site infections diagnosed after hospital discharge. Emerg Infect Dis 2003;9:196–203.
12. Wall PD, Deucy EE, Glantz JC, et al. Vertical skin incisions and wound complications in the obese parturient. Obstet Gynecol 2003;102:952–6.

13. Marrs CC, Moussa HN, Sibai BM, et al. Removal notice to The relationship between primary cesarean delivery skin incision type and wound complications in women with morbid obesity. Am J Obstet Gynecol 2014;210:319.e1-4. Am J Obstet Gynecol 2017;217:85.

14. Walton RB, Shnaekel KL, Ounpraseuth ST, et al. High transverse skin incisions may reduce wound complications in obese women having cesarean sections: a pilot study [e-pub ahead of print]. J Matern Fetal Nneonatal Med https://doi.org/10.1080/14767058.2017, accessed September 22, 2018.

15. Houston MC, Raynor BD. Postoperative morbidity in the morbidly obese parturient woman: supraumbilical and low transverse abdominal approaches. Am J Obstet Gynecol 2000;182:1033–5.

16. Chelmow D, Rodriguez EJ, Sabatini MM. Suture closure of subcutaneous fat and wound disruption after cesarean delivery: a meta-analysis. Obstet Gynecol 2004;103:974–80.

17. Hellums EK, Lin MG, Ramsey PS. Prophylactic subcutaneous drainage for prevention of wound complications after cesarean delivery—a metaanalysis. Am J Obstet Gynecol 2007;197:229–35.

18. Ramsey PS, White AM, Guinn DA, et al. Subcutaneous tissue reapproximation, alone or in combination with drain, in obese women undergoing cesarean delivery. Obstet Gynecol 2005;105:967–73.

19. Yu L, Kronen RJ, Simon LE, et al. Prophylactic negative-pressure wound therapy after cesarean is associated with reduced risk of surgical site infection: a systematic review and meta-analysis. Am J Obstet Gynecol 2018;218:200–10.

20. Smid MC, Smiley SG, Schulkin J, et al. The problem of the pannus: physician preference survey and a review of the literature on cesarean skin incision in morbidly obese women. Am J Perinatol 2016;33:463–72.

21. Rahman M, Temple JR, Breitkopf CR, et al. Racial differences in body fat distribution among reproductive-aged women. Metabolism 2009;58:1329–37.

22. Wagner DR, Heyward VH. Measures of body composition in blacks and whites: a comparative review. Am J Clin Nutr 2000;71:1392–402.

23. Rahman M, Berenson AB. Accuracy of current body mass index obesity classification for white, black, and Hispanic reproductive-age women. Obstet Gynecol 2010;115:982–8.