Impact of Obesity on Cesarean Delivery Outcomes

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ABSTRACT

Background: The rate of cesarean delivery has increased over the last 2 decades. Obesity is a risk factor for complications during pregnancy and cesarean procedures. The objective of this study was to evaluate cesarean delivery outcomes in patients with vs without obesity, and determine the impact of obesity on complications.

Methods: The medical records of patients who underwent a cesarean delivery from 2010 to 2014 were reviewed. Patients were grouped by body mass index (BMI) into obese (≥30kg/m^2) and non-obese (<30kg/m^2) cohorts for comparison.

Results: Nine hundred seventy-one patients were included; 432 whom had obesity, and 539 did not have obesity. The rate of gestational diabetes was increased among patients with vs without obesity (15.3% vs 5.8%; *P*<0.001). Obesity was associated with an increased incidence of surgical site infections (8.1% vs 2.4%; *P*<0.001), yeast infection (2.8% vs 0.2%; *P*<0.001), and seroma (2.8% vs 0.4%; *P*=0.002). Obesity was an independent risk factor for surgical site infections, regardless of wound closure technique (adjusted odds ratio=3.24, 95% CI, 1.66-6.32; *P*<0.001).

Conclusions: Obesity is a risk factor for wound infections after a cesarean delivery. As obesity rates increase, it is important to be aware of these risks after performing a cesarean delivery.

INTRODUCTION

The prevalence of physicians performing cesarean delivery has increased as medical care has become more accessible. Barber et al reported that the rate of cesarean delivery operations increased by over 40% from 2003 to 2009.[1] In addition, obesity is considered to be a major problem of epidemic proportions. It is a major risk factor for several health complications, specifically an increased risk of developing a surgical site infection (SSI) after general surgeries.[2] Additionally, more women with obesity are becoming pregnant than recorded at any other period of time.[3] Obesity was determined as a major risk factor to undergo a cesarean delivery rather than a vaginal delivery.[4-8] As cesarean deliveries become more common, the risk of obesity should be considered, and appropriate SSI prevention techniques implemented.

Recent literature has demonstrated that there is an association between obesity and increased rate of surgical site infections (SSIs) after undergoing a cesarean delivery.[9,10] Prior rates of developing a SSI in patients with obesity vs those without obesity have been reported as 11.71% vs 1.06%; 15.92% vs 7.82%; and 19.70% vs 9.96%, respectively.[8,9,11] These studies were conducted in major health systems rather than a hospital with a focus on serving a large population of patients living in rural areas. Additionally, literature illustrates obesity as a risk factor for developing gestational diabetes, preeclampsia, and/or pregnancy-induced hypertension.[5-8,12] Women with obesity also have a higher incidence of a previous cesarean delivery and the delivery of a macrosomic/higher weight infant.[7,12] Finally, both Basha et al and Johnson et al reported that the use of staples rather than sutures for skin closure during a cesarean delivery led to a higher rate of wound complications but not necessarily wound infection.[9,13]

The objective of this study was to evaluate cesarean delivery outcomes in patients with obesity compared to patients without obesity in a community teaching hospital to determine whether obesity was an independent risk factor for developing a SSI when adjusting for wound closure technique. We hypothesized that the rates of SSI and other risk factors after cesarean delivery would be observed at higher rates in the population with obesity.

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METHODS

A retrospective review of the electronic medical records of all patients who underwent an elective or scheduled cesarean delivery from January 2010 to May 2014 within a single health system was completed after receiving Institutional Review Board approval. Our health system is an integrated, multispecialty group practice with 27 regional clinics, serving 19 counties over a 3-state area. The primary medical center includes a 325-bed teaching hospital. The patient population served by our health system is a large rural community, with a population of approximately 50,000 in the primary medical center location, with an additional 65,000 in the surrounding area of the county. Preoperatively, all cesarean delivery incision sites were prepared and draped in the usual sterile fashion. Antibiotics were administered within 1 hour of skin incision. Upon completion of cesarean delivery, skin and fascial closure techniques were based on obstetrician discretion.

Patients were grouped according to their prenatal or first trimester body mass index (BMI). The group with obesity included patients with a BMI ≥30 kg/m^2 (obese group), while the group without obesity included those with a BMI <30 kg/m^2 (non-obese group). Patients who did not have a prenatal or first trimester BMI available were excluded from analysis. The obese and non-obese groups were compared by several demographic variables, past medical histories, preoperative complications, perioperative variables, postoperative outcomes, and infant birth weights. The primary endpoint was the incidence of SSIs diagnosed and treated within 30 days of delivery. SSIs were classified as superficial, deep, and organ space in accordance with the Centers for Disease Control and Prevention definitions.[14] Statistical analysis was performed using chi-square, Fisher's exact test, Wilcoxon rank sum test, student's t test, and a multivariate logistic regression. A *P* value <0.05 was considered significant.

RESULTS

During the study period, 1,026 patients underwent cesarean delivery. Fifty-five were excluded from further analysis due to unavailable prenatal weight. Overall, 971 patients were included in the study. Of the 971 patients included, 432 (44.5%) had obesity while 539 (55.5%) did not. The mean age was 30.5 ± 5.3 and 29.4 ± 5.4 years in the obese and non-obese groups, respectively. The prevalence of Type 2 diabetes mellitus, polycystic ovarian syndrome, history of a prior cesarean delivery, and gestational diabetes was higher in the obese vs non-obese group (Table 1).

Trial of labor occurred at a lower rate in the obese vs non-obese group, while labor was induced in a higher proportion of the obese group that tried labor (Table 2). Perioperative data including the mean length of stay, presence and duration of ruptured membranes, presence of meconium, and diagnoses of chorioamnionitis were similar in the 2 groups (Table 2). The types of anesthetic (general, spinal, or epidural) were used in similar proportions in each group (Table 3). During the operation, a vertical incision was used for a similar proportion of women with obesity vs women without obesity, and the mean estimated blood loss was also similar between the 2 groups, regardless of the type of incision (Table 3). Patients with obesity required a polydioxanone suture (PDS) rather than a vicryl suture for fascial closure at a

Table 1. Preoperative Characteristics for Obese and Non-obese Patients

Variable	Obese Group	Non-obese Group	*P* value
	N (%)		
Type 2 diabetes mellitus	29 (6.7)	1 (0.2)	<0.001
Polycystic ovarian syndrome	33 (7.6)	3 (0.6)	0.017
Previous cesarean delivery	211 (48.8)	222 (41.2)	0.017
Tobacco use			0.250
Current	59 (13.7)	62 (11.7)	
History	136 (31.6)	151 (28.4)	
Never	235 (54.7)	319 (60.0)	
Gestational diabetes	66 (15.3)	31 (5.8)	<0.001
Pregnancy-induced hypertension	25 (5.8)	22 (4.1)	0.220
Preeclampsia	34 (7.9)	27 (5.0)	0.068

Table 2. Labor, Delivery, and Perioperative Data for Obese vs Non-obese Patients

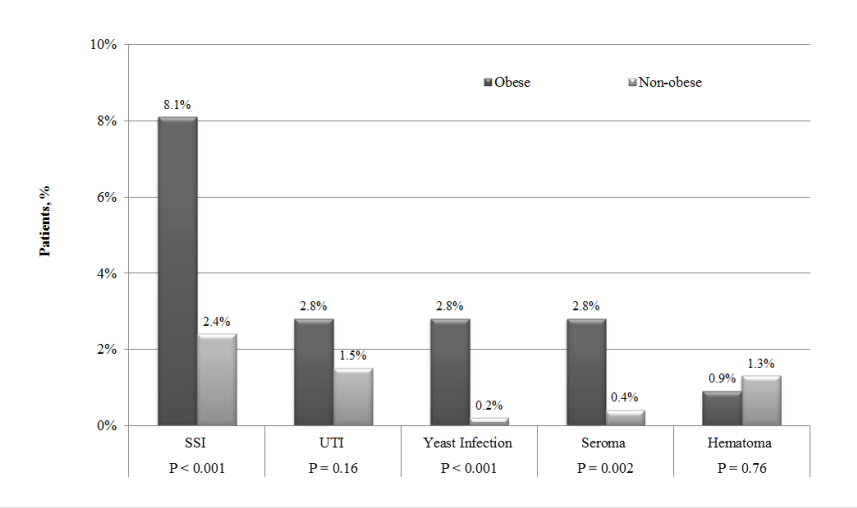
Variable	Obese Group	Non-obese Group	*P* value
Mean length of stay, days	3.7 ± 3.7	3.4 ± 1.6	0.700
Labor, n (%)	162 (37.5)	240 (44.5)	0.027
Induced labor technique, n (%)			
Cytotec	37 (8.6)	26 (4.8)	0.018
Foley	33 (7.6)	22 (4.1)	0.017
Prostaglandin	5 (1.2)	3 (0.6)	0.480
Pitocin	70 (16.2)	68 (12.6)	0.110
Scheduled C-section, n (%)	241 (55.8)	269 (49.9)	0.068
Pitocin Augmentation, n (%)	32 (7.4)	71 (13.2)	0.004
Rupture of Membranes (ROM)	154 (35.7)	217 (40.3)	-
Median time from ROM to delivery, hours (Interquartile range)	10.9 (4.3-10.9)	10.4 (5.0-17.9)	0.990
Meconium, n (%)	66 (15.3)	87 (16.2)	0.710
Chorioamnionitis, n (%)	19 (4.4)	39 (7.2)	0.064

Table 3. Operative Data for Obese and Non-obese Patients

Variable	Obese Group	Non-obese Group	*P* value
Vertical incision, n (%)	21 (4.9)	14 (2.6)	0.060
Mean EBL, cc	746.0 ± 380.6	754.1 ± 388.3	0.090
Anesthesia, n (%)			0.830
General	36 (8.3)	41 (7.6)	
Spinal	289 (66.9)	356 (66.2)	
Epidural	107 (24.8)	141 (26.2)	
Fascial closure, n (%)			0.006
Vicryl	133 (31.1)	213 (39.7)	
PDS	295 (68.9)	324 (60.3)	
Skin closure, n (%)			<0.001
Staples	20 (4.6)	3 (0.6)	
Sutures	412 (95.4)	536 (99.4)	

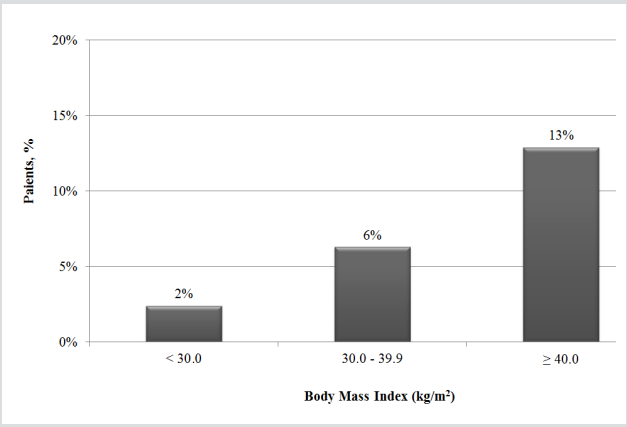
Abbreviations: EBL, excess blood loss; PDS, polydioxanone sutures.

Figure 1. Postoperative Complications in Obese and Non-obese Patients



Abbreviations: SSI, surgical site infections; UTI, urinary tract infections.

Figure 2. Surgical Site Infection Rate by Body Mass Index (BMI)



higher rate than patients without obesity. Additionally, the obese group had a higher proportion of patients requiring staples rather than sutures for skin closure. Overall, women with obesity delivered infants with a heavier mean delivery weight (3.50 ± 0.73 kg vs 3.36 ± 0.69 kg, *P*=0.003) and had a higher rate of delivering a macrosomic infant (25.0% vs 15.2%, *P*<0.001) compared to women without obesity.

Several postoperative complications were observed at higher rates in the obese group as compared to the non-obese group (Figure 1). When stratified further by BMI category, the SSI rates were 0, 7 (2%), 6 (3%), and 35 (8%) for patients with a BMI <18.5 kg/m^2, 18.5 to 24.9 kg/m^2, 25.0 to 29.9 kg/m^2, and ≥30 kg/m^2, respectively (*P*<0.001). Patients with obesity had higher rates of seromas, yeast infections around the wound, and SSIs (Figure 1). Additionally, with each 10-point increase in BMI, a corresponding increase in SSI rate was observed, with patients with severe obesity (≥40.0 kg/m^2) having the highest incidence of SSIs as compared to patients with obesity (30.0-39.9 kg/m^2) and patients without obesity (<30.0 kg/m^2) (Figure 2). Among the 48 patients with an SSI, the rates of superficial (62.9% vs 46.2%), deep (14.3% vs 30.8%), and organ space (22.9% vs 23.1%) SSIs were similar between the obese and non-obese groups, respectively (*P*=0.40). Seven (1.3%) patients in the non-obese group and 4 (0.9%) in the obese group received a blood transfusion (*P*=0.76). The SSI rate was 3% (n= 15) for planned cesarean delivery vs 7% (n=33) for unplanned cesarean delivery (*P*=0.003).

When comparing patients who had an SSI vs those who did not, regardless of BMI group, fascial closure with PDS was associated with an increased incidence of SSI vs fascial closure with vicryl (6.1% vs 2.9%, respectively; *P*=0.026). Skin closure with staples resulted in a higher rate of SSIs than closure with sutures (26.1% vs 4.4%, *P*<0.001). On multivariate logistic regression, after controlling for planned vs unplanned cesarean delivery, as well as skin and fascial closure techniques, obesity was an independent risk factor for developing a SSI (adjusted odds ratio=3.24, 95% CI [1.66-6.32], *P*<0.001).

DISCUSSION

Obesity continues to be prevalent in the United States among women of childbearing age. This study presents a comprehensive review of both preoperative variables and postoperative outcomes relating to the risks of obesity in pregnancy with a specific focus on complications after cesarean deliveries, including SSIs. We hypothesized that obesity would increase the chance for developing a SSI after a cesarean delivery as that correlation has been reported in prior general surgery literature.[2] Overall, obesity illustrated an increase in several complications prior to delivery, as well as increasing the chance of developing postoperative wound complications, especially the development of a SSI.

Maternal obesity was associated with increased diagnoses of Type 2 diabetes mellitus, gestational diabetes, polycystic ovarian syndrome, previous cesarean delivery, and higher weight infants. Each of these complications has been reported previously at higher rates in patients with obesity.[4-8,12] Furthermore, obesity led to a higher rate of developing a yeast infection of the wound or a wound seroma, which supports the findings reported by Basha et al.[13] Similar to previous studies observing SSI in cesarean delivery patients with obesity, SSIs were significantly more prevalent in the population with obesity in our study. Moreover, SSI rates increased incrementally with

each increase in BMI, where the highest rates were observed in patients with severe obesity (BMI ≥40.0 kg/m^2). This trend concurs with obesity as an independent risk factor for developing a SSI regardless of the type of fascial closure. These results follow similar patterns as studies that have recently proposed that obesity leads to higher rates of SSI after cesarean delivery.[8,9,11] Our study illustrated that obesity was an independent risk factor for developing a SSI regardless of the type of fascial closure, and that the use of staples for skin closure was associated with an increased rate of developing a SSI. However, there was an inadequate sample of patients with stapled skin closure to develop a multivariate model to determine whether the type of skin closure is another risk factor of developing SSI, in addition to the established risk factor of obesity. Interestingly, the SSI rate among patients with obesity in our series was 8.1%, slightly lower than other reports from more urban United States and international medical centers, with SSI rates ranging from 11.7% to 19.7% in patients with obesity. The reasons for this are largely unknown, though improved hand hygiene and SSI prevention practices (consistent preoperative skin preparation, antibiotics, and insulin drip for patients with diabetes) may account for some contributing factors.

These results ascertain that obesity is a major risk factor for patients having a cesarean delivery. Obesity may lead to increased risk of SSI based upon several factors. First, the greater amount of fat between the fascia and skin could cause disruption of or decrease blood flow to the wound leading to increased risk of infection.[10] Second, although it is difficult to measure or quantify, the pannus of a woman with obesity could obstruct the wound area from exposure to air leading to a moist and viable environment for microbes/infection to propagate. Finally, a large pannus places additional stress on the wound, which could lead to an opening in the wound where infection can more easily set in.

This study contains several limitations including the inherent limitations of a retrospective study design and being a single institution series. There was no prior standardization of the data for this study, which was abstracted from our electronic medical record system and included multiple obstetricians over a 5-year period. Future research to expand the sample size with the inclusion of patients from several institutions could further confirm these results. Finally, a randomized prospective study could further determine the association of SSI with regards to obesity, incision type, and closure type.

Overall, this study illustrates that additional precautions should be taken while performing a cesarean delivery and treating the wound area in patients with obesity. Such precautions could include using the pfannenstiel incision (low transverse incision) in all anatomically possible cases, using vicryl sutures for fascial closure and sutures for skin closure, and increasing emphasis on cleaning/treating the wound for the prevention of infection.

CONCLUSIONS

Obesity was associated with higher rates of gestational diabetes, diabetes mellitus, polycystic ovarian syndrome, previous cesarean delivery, macrosomia, yeast infection, and seroma formation following cesarean delivery. Surgical site infections were more prevalent in patients with obesity regardless of the type of fascial closure. As the obesity rate continues to rise and medical care becomes more accessible, health care providers, particularly in rural areas, should be aware of the impact of obesity on cesarean delivery outcomes. Further research is needed to identify the impact of obesity on skin closure and surgical site infections after cesarean delivery.

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REFERENCES

1. Barber EL, Lundsberg LS, Belanger K, Pettker CM, Funai EF, Illuzzi JL. Indications contributing to the rising cesarean delivery rate. *Obstet Gynecol*. 2011;118(1):29-38.

2. Dindo D, Muller MK, Weber M, Clavien PA. Obesity in general elective surgery. Lancet. 2003;361(9374):2032-2035.

3. Alanis MC, Villers MS, Law TL, Steadman EM, Robinson CJ. Complications of cesarean delivery in the massively obese parturient. *Am J Obstet Gynecol*. 2010;203(3):271.e1-7.

4. Hollowell J, Pillas D, Rowe R, Linsell L, Knight M, Brocklehurst P. The impact of maternal obesity on intrapartum outcomes in otherwise low risk women: secondary analysis of the birthplace national prospective cohort study. *BJOG*. 2014;121(3):343-355.

5. Scott-Pillai R, Spence D, Cardwell CR, Hunter A, Holmes VA. The impact of body mass index on maternal and neonatal outcomes: a retrospective study in a UK obstetric population, 2004-2011. *BJOG*. 2013;120(8):932-939.

6. Weiss JL, Malone FD, Ball RH, et al; FASTER Research Consortium. Obesity, obstetric complications and cesarean delivery rate – a population-based screening study. *Am J Obstet Gynecol*. 2004;190(4):1091-1097.

7. Bautista-Castaño I, Henriquez-Sanchez P, Alemán-Perez N, et al. Maternal obesity in early pregnancy and risk of adverse outcomes. *PLoS ONE*. 2013;8(11):e80410.

8. Magann EF, Doherty DA, Sandlin AT, Chauhan SP, Morrison JC. The effects of an increasing gradient of maternal obesity on pregnancy outcomes. *Aust N Z J Obstet Gynaecol*. 2013;53(3):250-257.

9. Johnson A, Young D, Reilly J. Caesarean section surgical site infection surveillance. *J Hosp Infect*. 2006;64(1):30-35.

10. Tipton AM, Cohen SA, Chelmow D. Wound infection in the obese pregnant woman. *Semin Perinatol*. 2011;35(6):345-349.

11. Wloch C, Wilson J, Lamagni T, Harrington P, Charlett A, Sheridan E. Risk factors for surgical site infection following caesarean section in England: results from a multicentre cohort study. *BJOG*. 2012;119(11):1324-1333.

12. Slavin VJ, Fenwick J, Gamble J. Pregnancy care and birth outcomes for women with moderate to super-extreme obesity. *Women Birth*. 2013;26(3):179-184.

13. Basha SL, Rochon ML, Quiñones JN, Coassolo KM, Rust OA, Smulian JC. Randomized controlled trial of wound complication rates of subcuticular suture vs staples for skin closure at cesarean delivery. *Am J Obstet Gynecol*. 2010;203(3):285.e1-8.

14. Centers for Disease Control and Prevention. Procedure-associated Module SSI. Surgical Site Infection (SSI) Event. January 2017. https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf. Accessed September 28, 2017.

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