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Cesarean Section Incision Complications and Associated Risk Factors: A Quality Assurance Project

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Abstract

Background: Today in the United States, approximately 30% of deliveries are performed by cesarean section. Wound infections and other post-operative complications represent a frequent morbidity which may be improved with an understanding of local risk factors. Objective: This project used a retrospective analysis of cesarean section incision complications and infection events along with patient chart information to identify potential risk factors associated with incisional wound complications at our institution. Methods: ICD9 codes identified 618 cesarean sections from July 2012 through June 2013. Of these, 59 were excluded. Twelve different data elements were examined and complications were divided into two categories: presence of infection and presence of seroma/hematoma. Statistics included univariate analysis and multiple logistic regressions to identify an odds ratio for associations using $P < 0.05$ as significant. Results: 73 (13.1%) of 559 patients developed a post-partum incision complication. Five logistic variables were included in amultiple logistic regression model for all incision *complications*. Three of the five variables had a significant odds ratio: emergent cesarean section, stapled skin closure, and preeclampsia. Five logistic variables were included in another multiple logistic regression model for all wound *infections.* Two of the five variables had a significant odds ratio: BMI > 33.4 and preeclampsia. Conclusions: Cesarean section rates account for approximately 30% of deliveries, with significant maternal morbidity associated with incisional wound complications. This study found multiple significant risk factors for both wound complications and infections. Preeclampsia was an indepen-

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dent risk factor for both wound complications and infections.

Keywords

Cesarean Wound Infection, Cesarean Wound Complication, Preeclampsia, Risk Factors

1. Introduction

Today, in the United States about one of every three deliveries is by cesarean section. Although this procedure has become routine, it is not benign. Cesarean section brings an increased risk of maternal morbidity and mortality when compared to vaginal deliveries [1]. One of the most commonly evaluated areas of maternal morbidity is wound infection/complications. There have been numerous studies evaluating these factors which increase the risk of infections [2] as well as the best form of wound closure for prevention. The purpose of this study is to serve as an intra department examination of maternal morbidity from wound complications related to cesarean sections and to evaluate individual risk factors. The goal is to establish a baseline wound complication rate, identify risk factors, and incorporate quality improvements to decrease the complication rate.

2. Methods

A systematic search was done by ICD9 codes to create a list of all cesarean sections from July 2012 to June 2013. A total of 618 cesarean sections were conducted during this time frame. A total of 59 of these were excluded from the study. There were two cases excluded for having a vertical midline incision. One case was excluded as it was a combination case with general surgery for an appendectomy with a ruptured appendix. One case was excluded as it was a combination case with plastic surgery for an abdominoplasty. The remaining 55 cases were excluded for inadequate follow up.

Each case was examined and data recorded to include: patient's age, height, weight, and gestational age, the incidence (primary/repeat cesarean), timing (before/after onset of labor), if antibiotics were given, type of wound closure, presence of chorioamnionitis, diabetes, preeclampsia, and rupture of membranes. Then each case was examined to see if there were any diagnosed wound complications. Complications were divided into two categories: infection and seroma/hematoma. Infection was defined as a wound breakdown requiring the use of antibiotics documented in the medical record. Seroma/hematoma was defined by the type of fluid collection inside the surgical wound. Both of these categories were also categorized on the need for surgical wound packing.

Statistical analysis. Patients with cesarean section deliveries between July 1, 2012 and June 30, 2013 were grouped as to whether they had post-partum incision complications or not. As incision infection was the most common complication a second set of analyses was performed focused on just incision infection as an outcome. Variables related to patient demographics, pregnancy complications, timing of the section and methods of closure were compared using univariate analyses methods. Logistic or categorical variables were compared using Pearson's chi square test. Parametric variables were compared using Student's *t* test. Non-parametric variables were compared using Mann-Whitney U test. These analyses were performed using Statistica software (Stat Soft, Tulsa, OK). Receiver operative curve analysis was performed to establish a threshold criterion level for parametric variables to allow conversion to logistic format. Those variables with univariate comparison that demonstrated differences or trends (P of 0.1 or less) were included in a logistic regression model. The final model was limited to those variables with significant contributions in the initial multiple logistic regression model (MediCalc Software, Ostend, Belgium). P values less than 0.05 were interpreted as significant.

3. Results

In total 559 patients with cesarean section deliveries between July 1, 2012 and June 30, 2013 with post-partum follow-up contributed data for this retrospective analysis. Of these patients, 73 (13.1%) developed a post-partum incision complication. The types and combinations of complications are shown in **Table 1**. **Table 2** shows comparisons for 9 logistic or categorical variables and 3 quantitative variables for incision complications (as discussed in the methods section). Five of these 12 variables had differences with P of 0.1 or less. From these,

Table 1. Distribution of types of cesarean incision complications in 559 patients.

Type of complication	N	Percentage
None	486	86.9
Infection[B]	22	3.9
Hematoma	8	1.4
Seroma	8	1.4
Infection with seroma[B]	2	0.4
Hematoma and packing	5	0.9
Infection and packing[A,B]	11	2.0
Dehiscence with packing[c]	6	1.0
Infection with seroma and packing[B]	5	0.9
Seroma and packing	5	0.9
Infection with hematoma and packing	1	0.2

[A]Wound packing performed to allow healing by secondary intention after wound opened; [B]Infection is the most common complication (41 of 73 cases with complications versus 20 with seroma, 14 with hematoma, 6 with otherwise uncomplicated dehiscence); [C]Two with wound vacuum applied.

Table 2. Comparisons of patients with and without incision complications after cesarean section.

Variable	No incision complication (n = 486)	Incision complication (n = 73)	P-value
Primary c-section	253 (47.9%)	30 (52%)	0.27[A]
C-section without labor	**246 (50.6%)**	**27 (37%)**	**0.03[A]**
Timing of c-section			**0.0004[A]**
Scheduled	**189 (38.9%)**	**18 (25%)**	
Emergent	**25 (5.1%)**	**12 (16%)**	
Non-emergent	272 (56.0%)	43 (59%)	
Closure with staples	**349 (71.8%)**	**62 (85%)**	**0.018[A]**
Closure with subcutaneous sutures	139 (28.6%)	21 (29%)	0.98[A]
Ruptured membranes	179 (36.8%)	33 (45%)	0.17[A]
Chorioamnionitis	54 (11.1%)	9 (12%)	0.76[A]
Diabetes during pregnancy	57 (11.7%)	7 (10%)	0.59[A]
Preeclampsia	**65 (13.3%)**	**18 (25%)**	**0.011[A]**
Age (years)	27.7 ± 5.8	27.2 ± 5.8	0.46[B]
BMI (kg/m^2)	34.2 ± 7.8	35.4 ± 8.5	0.22[C]
Gestational age (wks)	37.4 ± 3.8	36.8 ± 4.0 (n = 50)	0.24[C]

[A]Using Pearson's Chi square test; [B]Using Mann-Whitney U test; [C]Using Student's *t* test.

five logistic variables including whether the section was performed after labor had initiated, whether the section was not a scheduled section, whether the section was emergent, whether the skin was closed with staples, and whether preeclampsia complicated the pregnancy. The multiple logistic regression model showed three of the five were significant ($P < 0.05$). These were whether the cesarean was emergent, whether the skin was closed with staples, and if preeclampsia complicated the pregnancy (**Table 3**).

A second set of analyses was performed to examine the most common incision complications, infection. **Table 4** shows comparisons for the 9 logistic or categorical variables and 3 quantitative variables. Five of these 12 variables had differences of P of 0.1 or less. These included cesarean was performed after the initiation of labor, whether the skin was closed with staples, whether the subcutaneous space was closed, whether preeclampsia complicated the pregnancy, and the patient's body mass index (BMI),

As body mass index is a quantitative variable, Receiver Operator Curve (ROC) analysis was used to find a threshold value to converting this variable to a logistic variable. **Figure 1** shows the ROC plot for this comparison. The optimal threshold criterion of BMI was greater than 33.4 kg/m^2. The area under the curve for this relationship is 0.6 with 95% confidence limit of 0.58 to 0.66 which is significantly ($P = 0.006$) different from 0.5.

Table 3. Results of multiple logistic regression for variables associated with incision complications of all types and combinations following cesarean section.

Variable	Likelihood model[A]	
	Odd ratio (95% CI)	P-value
Section performed after labor initiated	1.7 (0.9 to 3.3)	0.13
Section was not scheduled	1.0 (0.5 to 2.2)	0.97
Section was emergent	**3.0 (1.4 to 6.5)**	**0.006**
Closure using staples	**2.0 (1.002 to 4.0)**	**0.049**
Pregnancy complicated with preeclampsia	**2.0 (1.04 to 3.9)**	**0.038**

[A]Model is significant (P = 0.032). However, no single factor was significant for use in model refinement.

Table 4. Comparisons of patients with and without incision infections after cesarean section.

Variable	No incision infection (n = 518)	Incision infection (n = 41)	P-value
Primary c-section	271 (52.3%)	25 (61%)	0.28[A]
C-section without labor	**258 (49.8%)**	**15 (27%)**	**0.10[A]**
Timing of c-section			0.17[A]
Scheduled	196 (37.78%)	11 (27%)	
Emergent	32 (6.2%)	5 (12%)	
Non-emergent	290 (56.0%)	25 (61%)	
Closure with staples	**375 (72.4%)**	**36 (87%)**	**0.031[A]**
Closure with subcutaneous sutures	**143 (27.6%)**	**17 (41%)**	**0.059[A]**
Ruptured membranes	194 (37.5%)	17 (41%)	0.059[A]
Chorioamnionitis	56 (10.8%)	7 (17%)	0.22[A]
Diabetes during pregnancy	60 (11.6%)	4 (10%)	0.72[A]
Preeclampsia	**71 (14.5%)**	**12 (29%)**	**0.007[A]**
Age (years)	27.7 ± 5.7	27.2 ± 6.2	0.64[B]
BMI (kg/m^2)	**34.1 ± 7.8**	**37.3 ± 8.2**	**0.013[B]**
Gestational age (wks)	37.3 ± 3.9	37.5 ± 3.2	0.80[B]

[A]Using Pearson's Chi square test; [B]Using Student's *t* test.

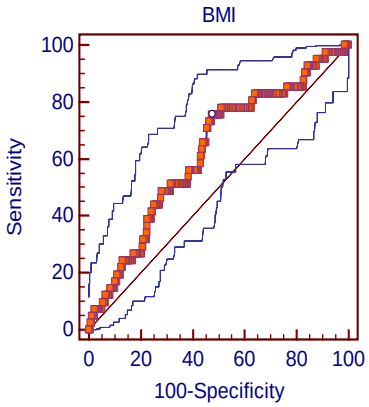

Figure 1. Receiver operator curve analysis plot for relationship of body mass index (BMI) to development of incision infection. The open circle represents the threshold criterion of BMI greater than 33.4 kg/m^2. The area under the curve is 0.6 with 95% confidence limit of 0.58 to 0.66. The sensitivity is 76% and the specificity is 53% for this optimal criterion.

This criterion has a sensitivity of 76% and a specificity of 53% and was used to construct the logistic variable for BMI.

As shown in **Table 5**, the multiple logistic regression model with these five variables showed BMI > 33.4 and preeclampsia complicated the pregnancy independently significant (P < 0.05) wound infection.

4. Discussion

Numerous studies have been conducted looking at cesarean wound complications. Recent studies have demonstrated a baseline wound infection rate between 7% - 13.9%, varying by types of skin closure and appraising individual risk factors [2]-[4]. In this retrospective study of 559 cesarean sections, there was a baseline wound complication rate of 13.1%.

Many studies have identified obesity as an independent risk factor. One study examined obesity and infectious morbidity in spite of prophylactic antibiotics [5]. Although the type of antibiotics given was not a primary outcome examined in our study, our hospital protocol is to give 2 grams of cefazolin intravenously prior to surgery. An additional study published in 2011, examined concentrations of prophylactic cefazolin and showed statistically decreased concentrations in subcutaneous fat and myometrial samples at the time of delivery. Of patients with a BMI between 30 - 39, 20% demonstrated concentration levels lower than the resistance level needed for appropriate bacterial treatment. This was even more pronounced (33%) in patients with a BMI > 40 [6].

A closer look at the relationship between BMI and wound complications related to cesarean sections was performed in 2000 comparing BMI and depth of subcutaneous space. They found a positive correlation of wound infections to an increase in space depth with no relationship to BMI [7]. A meta-analysis published in 2004 showed a 34% decrease in cesarean wound infections when re-approximating the subcutaneous fat if measuring > 2 cm in depth [8].

Preeclampsia complicating the pregnancy was identified as an independent risk factor for both wound complication and for wound infection. While numerous studies have identified preeclampsia as a risk factor, it is usually thought to be combined with obesity or other risk factors. This study shows preeclampsia as an independent risk factor. There is not good data to suggest the etiology of this. It may be theorized to be from decreased tissue perfusion, edema in the subcutaneous space, or for some other undiscovered reason. Further research needs to be done to identify the exact link between preeclampsia and wound complications and infections.

The other identifiable risk factors were whether the cesarean was done emergently. This is likely multifactorial. In regards to the skin closure, recent studies and meta-analysis show a significant decreased rate of breakdown/infection if the skin was closed with sutures.

There are some limitations to this study as it was a single institution retrospective analysis and there was no randomization of patients for comparison of treatment outcomes. However, this study was conducted to identify risk factors and hopefully influence physician practices/techniques. Additional studies are needed to confirm whether identification of these risk factors changes physician practice and decreases wound complications.

5. Conclusion

In conclusion, cesarean sections rates account for approximately 30% of deliveries, and there is significant maternal morbidity associated with wound complications. This study has successfully identified risk factors that have already been previously described, but interestingly identified preeclampsia as an independent risk factor for both wound complications and wound infections.

Table 5. Results of multiple logistic regression for variables associated with incision infection following cesarean section.

Variable	Model[A]	
	Odd ratio (95% CI)	P-value
BMI > 33.45 kg/m^2	**2.3 (1.1 to 4.9)**	**0.03**
Patient had pre-eclampsia during pregnancy	**2.4 (1.1 to 5.0)**	**0.02**
Section performed after labor initiated	1.9 (0.95 to 3.7)	0.07
Closure with staples	2.2 (0.8 to 6.0)	0.11
Subcutaneous sutures used during closure	1.6 (0.8 to 3.1)	0.22

[A]Model is significant (P = 0.0001).

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