Adhesion development and morbidity after repeat cesarean delivery

Togas Tulandi, MD, MHCM; Mohammed Agdi, MD; Afsoon Zarei, MD; Louise Miner, MD; Vanja Sikirica, PharmD

OBJECTIVE: The purpose of this study was to evaluate the development and implications of intraabdominal adhesions after repeat cesarean section delivery (CS).

STUDY DESIGN: We reviewed the charts of 1283 women who underwent repeat CS and 203 other women who underwent primary CS. Primary outcome measures were incidence and extent of adhesions, incision-to-delivery interval, and operating time.

RESULTS: No adhesions were found in primary CS. Compared with those women with a second CS (24.4%), significantly more women had adhesions after 3 CSs (42.8%; 95% confidence interval [CI], 0.84-0.99). Compared with a first CS (7.7 ± 0.3 minutes), the delivery time was significantly longer at subsequent CSs (second CS, 9.4 ± 0.1 minutes; 95% CI, 1-2; third CS, 10.6 ± 0.3 minutes; 95% CI, 2-4; ≥ 4 CSs, 10.4 ± 0.1 minutes; 95% CI, 1-2). However, complication rates in those women with ≥ 2 CSs were comparable with primary CS.

CONCLUSION: Increased adhesion development and a longer time to delivery were found with each subsequent CS.

Key words: adhesion, cesarean section delivery, delivery time, operating time, repeat cesarean section delivery

Adhesion development and morbidity after repeat cesarean delivery.

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According to the Canadian Institute for Health Information 2007 report, the number of cesarean deliveries is at a record high in Canada because 26.3% of all Canadian women delivered children by cesarean delivery in the 2005-2006 measurement year. This represents an increase of 0.7% over the previous year because almost all territories had an increase in rate of cesarean deliveries. These rates are similar to or approaching some United States rate estimates where cesarean deliveries represented 31% of all deliveries in 2006. Similar to other abdominal operations, cesarean delivery is associated with intraabdominal adhesions that lead to longer operating time with repeated cesarean deliveries.

The growing rate of cesarean deliveries prompted us to investigate the impact of adhesions on cesarean deliveries and the effect on fetal and maternal health in a Canadian population. As such, the purpose of our study was to evaluate the incidence and extent of intraabdominal adhesions after repeat cesarean delivery and their clinical implications.

MATERIALS AND METHODS

We reviewed medical records of 1283 consecutive women who underwent repeat cesarean delivery at the Sir Mortimer B. Davis, Jewish General Hospital, which is a McGill University teaching hospital in Montreal during the period of December 1999 to January 2008. The first 2 patients per month who underwent primary cesarean delivery (203 patients) during the study period served as the baseline comparison group. Because adhesion after primary cesarean delivery is generally minimal or nonexistent, we believed this number of control patients was adequate to give a representative sample of adhesion development in primary cesarean delivery. Information was retrieved from the hospital’s medical file and crosschecked with the birthing room records to capture demographic and medical information on all 1486 patients. Cases with a complete operative report and delivery record were included. We excluded patients who underwent emergency repeat cesarean delivery, cesarean delivery with classic or T incision and with pelvic infection or endometriosis stage III or IV. The research and ethics board of the hospital approved this study.

The primary outcome measures were the incidence and extent of adhesions, the incision-delivery interval (time to delivery), and the operating time (defined as skin incision to skin closure). The site and nature of the adhesions were evaluated with an adhesion scoring system. Because there has not been a validated adhesion scoring system to be used after cesarean delivery, we graded adhesions at 6 adhesion sites (Table 1) and assigned a score of 0 for no adhesion, 1 for filmy adhesion, and 2 for dense adhesion at each site, for a minimum score of 0 and a maximum score of 12. For example, if all sites were involved with dense adhesions, a total score would be 12.

Secondary outcome measures included intra- and postoperative complications that were related to the process...
dure that included estimated amount of blood loss, urinary tract infection, Apgar score of the newborn infant, length of hospital stay, postpartum hemorrhage, wound and uterine dehiscence, bladder or bowel injury, and any additional surgery, including hysterectomy.

**Statistical analysis**

Women were categorized on the basis of the number of cesarean deliveries that they had undergone (1, 2, 3, or ≥4 cesarean deliveries). The frequency of occurrence of each outcome measure was captured. The normality of data distribution was tested with the use of the Shapiro-Wilk test. Because the data were not distributed normally, the Mann Whitney U test was used to compare continuous variables. Proportions were compared with the use of the χ² or Fisher exact test, when appropriate. The results were expressed as a mean ± SEM. The differences were considered statistically significant if α was < .05. For continuous variables, we used 95% confidence interval (CI) for the difference between medians.

**RESULTS**

Of the 1486 women, 1283 women had elective repeat cesarean deliveries (2 for 955 women; 3 for 255 women; 4-8 for 73 women); 203 women had a primary cesarean delivery. Because of the small number of cases with ≥4 cesarean deliveries, these 73 cases were grouped into 1 category (4 cesarean deliveries, 46 women; 5 cesarean deliveries, 16 women; 6 cesarean deliveries, 4 women; 7 cesarean deliveries, 4 women; and 8 cesarean deliveries, 1 woman). The mean age and body mass index of patients who underwent primary cesarean delivery and second, third, or 4 or more cesarean deliveries were 31.5 ± 0.6, 33.5 ± 0.2, 34.6 ± 0.3, 35.1 ± 0.6 years and 30.8 ± 1.1, 32.4 ± 1.6, 29.3 ± 1.2, and 29.7 ± 1.0 kg/m², respectively. None of the patients had adhesion barrier use.

No adhesions were found in women who underwent primary cesarean delivery. Compared with women with a second cesarean delivery (24.4%), more patients were found to have adhesions after 3 (42.8%; 95% CI, 0.84-0.99; P < .05), and ≥4 cesarean deliveries (47.9%; 95% CI, 0.91-0.98; P < .001; Figure). The total adhesion scores in those with 2, 3, and ≥4 cesarean deliveries were 1.8 ± 0.1, 2.1 ± 0.1 (P < .05, compared with second cesarean delivery), and 1.9 ± 0.1, respectively (P = not significant). The sites of adhesions were predominantly between the abdominal wall and uterus (range, 2 to ≥4 cesarean deliveries; 47.8-53.7%) and between the bladder and the uterus (range, 2 to ≥4 cesarean deliveries; 25.9-35.0%; Table 1).

Patients could have had multiple adhesion sites. The proportion of sites to the number of patients increased with each repeat cesarean delivery. For example, of 955 patients at a second cesarean delivery, there were 289 adhesion sites found; 147 sites were found in 255 patients who underwent a third cesarean delivery, and 46 sites were found in 73 patients who underwent ≥4 cesarean deliveries (0.30, 0.58, and 0.63 sites per patient, respectively). When we evaluated all adhesion sites, dense adhesions were found in 140 sites (48.4%) at the second cesarean delivery, in 83 sites (56.4%) at the third cesarean delivery, and in 26 sites (56.5%) were found at ≥4 cesarean deliveries (Table 1). The proportion of patients with dense adhesion also increased from the second to ≥4 cesarean delivery group (0.15, 0.33, and 0.36 sites per patient, respectively). Compared with first cesarean delivery (7.7 ± 0.3 min), the delivery time was significantly longer at subsequent cesarean deliveries (second, 9.4 ± 0.1 min; 95% CI, 1-2; third, 10.6 ± 0.3 min; 95% CI, 2-4; ≥4, 10.4 ± 0.1 min; 95% CI,
1-2). The delivery time and the total operating time of the repeat caesarean deliveries among patients with adhesions are significantly longer than those without adhesions (Table 2). However, when we compared repeat caesarean deliveries in which there were no adhesions, there were no significant time differences. The estimated blood loss, length of hospital stay, and Apgar score among women who underwent primary (671.7 ± 13.0 mL; 4.8 ± 0.2 days; 8.9 ± 0.0) and repeated caesarean deliveries in the presence or absence of adhesions were comparable. Among patients with primary caesarean delivery, 1 patient had placenta previa (0.5%), but we did not encounter any placenta accreta. Placenta accreta was found in 6 patients at second caesarean delivery (0.6%), in 1 patient at the third caesarean delivery (0.4%), and in 1 patient with ≥ 4 caesarean deliveries (1.4%). Placenta previa was found in 2 patients at second caesarean delivery (0.2%), in 1 patient at third caesarean delivery (0.4%), and in 1 patient with ≥ 4 caesarean deliveries (1.4%). There was no significant difference in the incidence of placenta accreta and previa among all the groups.

Table 3 shows other morbidities that are related to primary and repeat caesarean deliveries. The rates of most of these outcomes were low, and we did not encounter uterine rupture. Because the morbidities occurred infrequently, we also compared their occurrence in a dichotomous fashion between the following 2 groups: primary caesarean vs any repeat caesarean section delivery (second through eighth). However, the complication rates were comparable (P = .636; 95% CI, 0.66-1.99).

In analyzing the additional time, we wondered whether surgical pace of the surgeon influenced our outcome. To evaluate whether the surgical pace of the surgeons (total, 16 surgeons) affected the delivery and operating time, we calculated the surgical pace of each surgeon from the total operating time of the primary caesarean delivery (skin incision to skin closure). There was a high correlation between the delivery time and the operating time among all patients (correlation coefficient, 0.61; 95% CI, 0.17-0.21; P < .0001); these 2 time variables were not influenced by the surgeons’ surgical pace (correlation coefficient, -0.16; 95% CI, -0.27 to 0.16 and -0.25; 95% CI, -1.42 to 0.63, respectively). There was no correlation between body mass index and delivery time (correlation coefficient, 0.02; 95% CI, -0.12 to 0.14) or operating time (correlation coefficient, 0.07; 95% CI, -0.28 to 0.57).

**TABLE 2**

<table>
<thead>
<tr>
<th>Cesarean delivery</th>
<th>Delivery time (min)</th>
<th>Operating time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary (n = 203)</td>
<td>7.7 ± 0.3</td>
<td>33.9 ± 0.8</td>
</tr>
<tr>
<td>Absence of adhesions (n = 722)</td>
<td>8.9 ± 1.2</td>
<td>34.2 ± 0.7</td>
</tr>
<tr>
<td>Presence of adhesions (n = 233)</td>
<td>10.7 ± 0.3</td>
<td>39.0 ± 0.2</td>
</tr>
<tr>
<td>P value (95% CI)</td>
<td>&lt;.0001 (1-2)</td>
<td>&lt;.0001 (2-7)</td>
</tr>
<tr>
<td>3 (n = 255)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absence of adhesions (n = 146)</td>
<td>8.9 ± 0.3</td>
<td>37.1 ± 1.3</td>
</tr>
<tr>
<td>Presence of adhesions (n = 109)</td>
<td>12.8 ± 0.6</td>
<td>47.9 ± 3.4</td>
</tr>
<tr>
<td>P value (95% CI)</td>
<td>&lt;.0001 (2-4)</td>
<td>&lt;.0001 (4-12)</td>
</tr>
<tr>
<td>≥ 4 (n = 73)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absence of adhesions (n = 38)</td>
<td>8.4 ± 0.7</td>
<td>35.3 ± 2.6</td>
</tr>
<tr>
<td>Presence of adhesions (n = 35)</td>
<td>12.4 ± 0.9</td>
<td>47.1 ± 2.6</td>
</tr>
<tr>
<td>P value (95% CI)</td>
<td>&lt;.001 (1-6)</td>
<td>&lt;.002 (4-21)</td>
</tr>
</tbody>
</table>

**COMMENT**

Most studies that evaluate postsurgical adhesion formation rely on second-look laparoscopy. The inconvenience of a second-look procedure, especially in the postpartum period, is self-evident. Accordingly, there are very few studies that have looked at adhesions after caesarean delivery in the literature. With a great number of repeat caesarean deliveries in our institution, we could evaluate adhe-
Morbidity that is associated with primary and repeated cesarean deliveries

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cesarean delivery (n)</th>
<th>Sum of ≥ 2 (n = 1283)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary (n = 203)</td>
<td>2 (n = 955)</td>
</tr>
<tr>
<td>Bladder injury</td>
<td>0</td>
<td>4 (0.4%)</td>
</tr>
<tr>
<td>Bowel injury</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>4 (6.2%)</td>
<td>2 (0.2%)a</td>
</tr>
<tr>
<td>Uterine dehiscence</td>
<td>0</td>
<td>19 (1.9%)</td>
</tr>
<tr>
<td>Injury to uterine vessels</td>
<td>1 (0.5%)</td>
<td>2 (0.2%)</td>
</tr>
<tr>
<td>Wound infection</td>
<td>3 (1.5%)</td>
<td>4 (0.4%)</td>
</tr>
<tr>
<td>Postpartum fever</td>
<td>6 (2.9%)</td>
<td>10 (1.0%)</td>
</tr>
<tr>
<td>Wound dehiscence</td>
<td>0</td>
<td>3 (0.3%)</td>
</tr>
<tr>
<td>Pulmonary emboli</td>
<td>0</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Hysterectomy</td>
<td>0</td>
<td>1 (0.1%)</td>
</tr>
<tr>
<td>Postpartum hemorrhage</td>
<td>0</td>
<td>1 (0.1%)</td>
</tr>
</tbody>
</table>

*a P < .05, compared with second cesarean delivery; b P < .002, compared with second cesarean delivery.


Adhesions formation in a large consecutive series of patients who underwent repeat cesarean deliveries, which included women with > 4 cesarean deliveries.

The incidence of intraabdominal adhesions in women who underwent repeat cesarean section delivery steadily rose for each subsequent delivery (2 cesarean deliveries, 24.4%; 3 cesarean deliveries, 42.8%; ≥ 4 cesarean deliveries, 47.9%). Total adhesions scores among all groups were similar, which suggests similar adhesion density in patients across repeat cesarean deliveries. However, the proportion of adhesion sites to number of patients and the proportion of dense adhesion sites increased steadily across second, third, and ≥ 4 cesarean deliveries, which implies that more adhesion sites and more dense adhesion sites are involved with each subsequent cesarean delivery.

In general, the development and consequences of adhesions are not well studied. In a similar, but smaller study, Morales et al3 reported a higher rate of intraabdominal adhesions: 46% at the second and 75% at the third cesarean delivery.3 This discrepancy could be due to our exclusion of women with emergency cesarean delivery and those with previous classic or T incision and stage III and IV endometriosis. Conversely, similar to their findings, most of the adhesions in our cases were between the uterus and bladder or anterior abdominal wall, and there were increases in the rate of dense adhesions across each cesarean delivery. They also reported 4% prevalence of adhesions among women who underwent primary cesarean delivery; we had none. This discrepancy could be due to conditions that we excluded in our study.

Other studies that have evaluated adhesion development after cesarean delivery did not report overall adhesions; rather, they stratified adhesions into minor or dense adhesions. Soltan et al4 found rates of dense adhesion in repeat cesarean section delivery to be similar to ours: 36.1% after second, 39.4% after third, and 63.6% after ≥ 4 cesarean deliveries (we found 48.4%, 56.4%, and 56.5%, respectively). Makoha et al5 looked at the rates of various morbidities in a study of 3191 women and found severe adhesions rates slightly lower than ours (11.5%, 26.0%, and 44.8% of second, third, and fourth cesarean section deliveries, respectively). Similar results are also supported by other studies.6

Among other outcomes, we found that both delivery and operating time in women with adhesions are significantly longer than in those women without adhesions. Although the difference was only a few minutes, these differences were significantly higher in each repeated cesarean delivery. To the best of our knowledge, this is the first study that has shown the attribution of how much extra time adhesions potentially add to each delivery and overall operating time. This delay is important, especially in the presence of fetal distress.

From an economic perspective, in an era of increasingly constrained resources and rising healthcare costs, additional time in the delivery room or overall operating time can lead to backlogs and increased pressure or reduced revenue to the healthcare system. In fact, a previous study of US costs of adhesiolysis in 1994 showed that $1.3 billion was the overall inpatient expenditure for adhesiolysis.7

There were 4 cases of bladder injury that were observed throughout the study, all of which occurred at the second cesarean delivery (0.4%) during which dense adhesions between the uterus and bladder were encountered. This is in agreement with 2 previous large retrospective studies; a case-control study of 14,757 cesarean deliveries (0.28%) and a retrospective cohort study of 25,005 cesarean deliveries (0.43%).8,9 Whether
obstetricians are more careful in creating the bladder flap in women who have had a cesarean delivery is unknown. It is also unclear whether the creation of the bladder flap may cause the development of more adhesions, although the second highest rate of development of adhesions is between the bladder and uterus. The clinical implications of this finding, such as the potentially expanded length of stay, are unknown. Most studies report low rates of uterine rupture.5,8,9 We did not encounter any uterine rupture in our series. In addition, our rates of placenta accreta or previa were quite similar to others.5,10

The incidence of urinary tract infection in our study seems to be the highest after primary cesarean delivery and lower at repeat cesarean deliveries. Perhaps this is related to the fact that >90% of primary cesarean deliveries were performed on an emergency basis. The patients had had prolonged labor and had undergone numerous pelvic examinations. In addition, the staff took their time to prepare the urethra before inserting the catheter before repeat cesarean deliveries. The rates of hysterectomy and wound dehiscence were also similar among all patients with repeated cesarean delivery but appeared to be higher relative to patients with primary cesarean delivery. In a cesarean delivery registry by Silver et al,11 maternal morbidity that included the rate of hysterectomy in women with multiple previous cesarean delivery was higher than in those women with primary cesarean deliveries and in other studies.5,10

Not all our results are clearly in agreement with previous studies. For example, Nisenblat et al10 found a significant difference in excessive blood loss between women who undergo second cesarean delivery vs ≥3 cesarean deliveries (7.9% vs 3.3%). Similarly, Makoha et al5 found increasing rates of postoperative hemoglobin deficit and blood transfusions. Conversely, Soltan et al4 did not, which is in line with our results. Apgar scores similarly were mixed in the literature, with some studies showing a difference and some not.3,4,8,10 Large prospective studies are needed to evaluate more accurately the effects of these complications. It is also important to note that these were planned repeat cesarean deliveries; therefore, maternal and fetal outcome results can be interpreted only for elective cesarean deliveries. Emergency cesarean delivery data need to be further studied.

Our study was not powered to test for statistical differences among our secondary endpoints, such as maternal and fetal outcomes. For this reason, we stratified the morbidity data by primary vs second cesarean delivery (≥2). It seemed that bladder and bowel injury, uterine and wound dehiscence, hysterectomy, and postpartum hemorrhage occurred more frequently in secondary cesarean deliveries. Results of our study support previous findings that overall there is more morbidity associated with repeat cesarean delivery.5,8,10

We also evaluated whether closure of parietal peritoneum affected the development of adhesions in repeated cesarean section deliveries. In cases in which the method of abdominal closure was evaluable, no significant difference was found in the prevalence of adhesions at second cesarean delivery between those with (17/56; 30.4%) or without peritoneal closure (101/385; 26.2%) and at the third cesarean delivery (32/67; 47.7% vs 50/111; 45.1%) and in women with ≥4 cesarean deliveries (27/57; 47.4% vs 7/11 63.6%). Our study demonstrated that closure of parietal peritoneum did not appear to affect adhesion formation. The literature appears to be mixed on this topic. Indeed, the effects of peritoneal closure on adhesion formation remain unclear. A few authors suggest that it does affect or prevent adhesion development12-14; others do not.15,16 In fact, 2 randomized studies showed completely opposite results.15,16

Because of the retrospective nature of adhesion evaluation, there are inherent limitations of our study. The use of medical records may introduce the underreporting of the true incidence and severity of adhesion development. We also do not have any evidence to document that practice patterns or system changes within our time period of study contributed to changes in results over time. However, the delivery and operating times provide an objective evaluation of the difficulty of the cesarean delivery. The strength of our study is the large number of consecutive patients who underwent repeated cesarean deliveries from a single institution, especially those with ≥4 cesarean deliveries.

Our study findings suggest that, in a large Canadian teaching hospital, adhesions are common, that their extent and density increase with repeated cesarean deliveries, and that they increase time to delivery of the fetus and time of the procedure. We conclude that increased adhesion development and longer delivery time are found with each subsequent cesarean delivery.

REFERENCES
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