

Clinical relevance of intra-abdominal adhesions in cesarean delivery

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Received: 16 January 2011 / Accepted: 20 January 2011 / Published online: 12 February 2011
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Abstract The objective of this study was to evaluate the prevalence and extent of intra-abdominal adhesions at cesarean deliveries (CS) and their clinical relevance. We studied 490 cases of primary CS, 430 first repeat, and 106 cases of second or third repeat CS. Using a standard scoring system, the prevalence, extent, and consistency of adhesions were evaluated prospectively. We also examined the incision–delivery interval and the total operating time. At repeat CS, adhesions were found mainly between the uterus and the bladder or the abdominal wall. Dense adhesions to the bladder and to the abdominal wall were significantly more after ≥ 2 CSs (46.3% and 48.2%) than after one CS (29.8% and 25.6%). The adhesions on these areas were also more severe after ≥ 2 CSs than after one CS. There was a significant correlation between the adhesion score and the interval between the incision and delivery ($r=0.23$, $P<0.0001$) and the operating time ($r=0.26$, $P<0.0001$). CS leads to adhesion formation mainly between the uterus and the bladder and between the uterus and the anterior abdominal wall.

Keywords Cesarean · Repeat cesarean · Adhesion · Delivery time · Operating time

Objective

In 1965, when it was first measured, the US national cesarean delivery (CS) rate was 4.5% [1]. In 2007, national vital statistics data estimates indicated that 31.8% of all deliveries were via the CS route in the US. It marks the 11th year in a row that the rates increased and a new all-time high [2]. This has made CS the most common operation performed on US women with 1.37 million cesareans in 2007 [2].

Similar to other abdominal operations, CS is associated with intra-abdominal adhesions leading to longer operating time with subsequent cesareans. The results of the few studies on adhesion development are congruent with each other in the direction of effect, indicating that adhesion develop more and with greater density with each repeat cesarean section. For example, Morales et al. found that 46–83% of women develop adhesions after repeat CS (second through fourth CS), and the extent and density of the adhesions increased with each repeat CS [3]. In another study, Tulandi et al. reported increased adhesion development and longer time to delivery in subsequent cesarean [4].

The aim of our study was to evaluate the prevalence and extent of intra-abdominal adhesions after CS and their clinical implications.

Materials and methods

The study was performed in the Department of Obstetrics and Gynecology at the Sir Mortimer B. Davis, Jewish General Hospital, a McGill University teaching hospital in Montreal from 2008 to 2009. We studied 1,026 women who underwent CS. Using a standard adhesion scoring system, the prevalence, extent, and consistency of adhesions at the time of CS

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were graded prospectively. We also examined the incision–delivery interval (delivery time), the total operating time, as well as the Apgar score and the fetal cord pH of the baby, and the postoperative complication prospectively.

Demography of the patients and other medical information were retrospectively retrieved from the hospital medical charts and independently crosschecked twice by two of the study investigators (BAS and GA). Patients who had had previous uterine surgery by abdominal approach such as myomectomy, cesarean with classical or T incision, history of pelvic infection, presence of stage III or IV endometriosis, and those with incomplete adhesion score were excluded.

The primary outcome measures were the prevalence, extent and consistency of adhesions, the incision–delivery interval, and the operative time at the primary cesarean or repeat CS. The secondary outcome measures were Apgar score and fetal cord pH of the newborn. The site and nature of adhesions were graded using an adhesion scoring system. We graded adhesions at four adhesion sites, and assigned a score of 0 for no adhesions, 1, 2, or 3 for filmy adhesions and 2, 4 or 8 for dense adhesions. The extent of adhesions was marked as enclosing $\leq 1/3$, $1/3$ to $2/3$, or $>2/3$ of the previous cesarean incision, respectively.

Statistical analysis

Normality of data distribution was tested using the Shapiro–Wilk's test. For continuous variables, inferential testing was conducted using the Student *t* test for normally distributed data. For non-normally distributed data, the Mann–Whitney test was used. Proportions were compared using Chi-Square or Fisher's exact test when appropriate. The differences were considered significant if *P* was less than 0.05.

Table 1 Profile of 1,026 women who underwent primary cesarean delivery (CS), one repeat and over two-repeat cesareans

	Primary (<i>n</i> =490)	Repeat 1 CS (<i>n</i> =430)	Repeat ≥ 2 CS (<i>n</i> =106)
Age	32.5 \pm 0.2	34.6 \pm 0.2	34.8 \pm 0.5
Gravidity	1.9 \pm 0.9	2.9 \pm 0.05	3.8 \pm 0.2
Parity	0.4 \pm 0.04	1.5 \pm 0.03	2.0 \pm 0.08
Ethnicity			
Caucasian	273 (55.7%)	218 (50.7%)	54 (50.9%)
Asian	53 (10.8%)	77 (17.9%)	8 (7.5%)
African descent	66 (13.5%)	56 (13%)	25 (23.6%)
Hispanic	71 (14.5%)	62 (14.4%)	13 (12.3%)
Others	27 (5.5%)	17 (4%)	6 (5.7%)

Table 2 Prevalence, site and extent of adhesions at repeat cesarean delivery (CS)

	Repeat 1 CS (430)	Repeat ≥ 2 CS (106)	<i>P</i> value
Filmy adhesion, uterus to bladder			
1/3 adhesion	155 (36.0%)	30 (28.3%)	NS
1/3–2/3 adhesion	52 (12.1%)	13 (12.3%)	NS
>2/3 adhesion	32 (7.4%)	13 (12.3%)	NS
Total	239 (55.5%)	56 (52.9%)	NS
Dense adhesion, uterus to bladder			
1/3 adhesion	70 (16.3%)	20 (18.9%)	NS
1/3–2/3 adhesion	39 (9.1%)	14 (13.2%)	NS
>2/3 adhesion	19 (4.4%)	15 (14.2%)	0.0005
Total	128 (29.8%)	49 (46.3%)	0.001
Filmy adhesion, uterus to abdomen			
1/3 adhesion	102 (23.7%)	19 (17.9%)	NS
1/3–2/3 adhesion	35 (8.1%)	11 (10.4%)	NS
>2/3 adhesion	14 (3.3%)	6 (5.7%)	NS
Total	151 (35.1%)	36 (34%)	NS
Dense adhesion, uterus to abdomen			
1/3 adhesion	58 (13.5%)	22 (20.8%)	NS
1/3–2/3 adhesion	38 (8.8%)	16 (15.1%)	NS
>2/3 adhesion	14 (3.3%)	13 (12.3%)	0.0004
Total	110 (25.6%)	51 (48.2%)	0.0001
Filmy adhesion, uterus to intestine			
1/3 adhesion	44 (10.2%)	10 (9.4%)	NS
1/3–2/3 adhesion	10 (2.3%)	4 (3.8%)	NS
>2/3 adhesion	1 (0.2%)	3 (2.8%)	<0.05
Total	55 (12.7%)	17 (16%)	NS
Dense adhesion, uterus to intestine			
1/3 adhesion	11 (2.6%)	5 (4.7%)	NS
1/3–2/3 adhesion	6 (1.4%)	1 (0.9%)	NS
>2/3 adhesion	3 (0.7%)	3 (2.8%)	NS
Total	20 (4.7%)	9 (8.5%)	NS
Filmy adhesion, uterus to omentum			
1/3 adhesion	63 (14.7%)	20 (18.9%)	NS
1/3–2/3 adhesion	19 (4.4%)	10 (9.4%)	NS
>2/3 adhesion	2 (0.5%)	5 (4.7%)	0.002
Total	84 (19.6%)	35 (33%)	0.004
Dense adhesion, uterus to omentum			
1/3 adhesion	35 (8.1%)	10 (9.4%)	NS
1/3–2/3 adhesion	17 (4%)	5 (4.7%)	NS
>2/3 adhesion	2 (0.5%)	3 (2.8%)	NS
Total	54 (12.6%)	18 (16.9%)	NS

Results

Of 1,026 women, 490 had had primary CS, 430 women had one repeat CS and 106 had two or three-repeat CSs. The number of women who had undergone three-repeat CS was

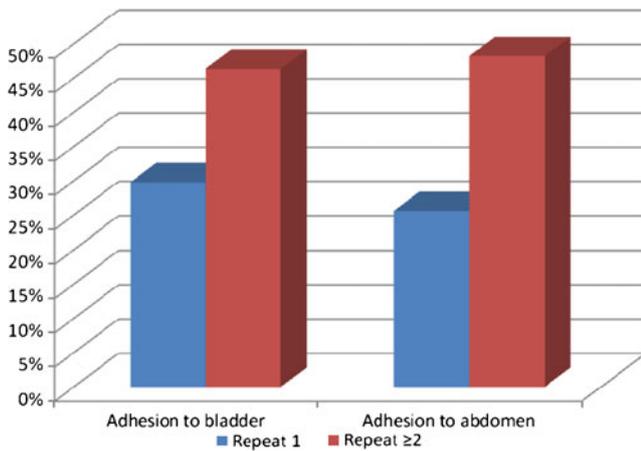


Fig. 1 Dense adhesions between the uterus and the bladder and between the uterus and the abdominal wall at repeat cesarean delivery

only 12. Accordingly, we combined cases that had undergone two- and three-repeat cesareans. The mean age of the patients who underwent primary CS, one repeat CS and ≥2 repeat CSs were 32.5±0.2 years, 34.6±0.2 years, and 34.8±0.5 years, respectively. Other demographic data were comparable (Table 1). None of the patients had previous adhesion barrier placement.

No adhesions were found in women who underwent primary cesarean. At repeat CS, adhesions were found mainly between the uterus and the bladder, and between the uterus and the anterior abdominal wall (Table 2). Dense adhesions between the uterus and the bladder and between the uterus and the abdominal wall were significantly higher after ≥2 CSs (46.3% and 48.2%) than after one CS (29.8% and 25.6%; Table 2, Fig. 1). The adhesions on these areas were also more severe after ≥2 CSs than after one CS (Table 3). The estimated blood loss was 672.1±8.9 ml at primary CS, 628.7±7.8 ml at 2nd CS, and 659.9±21.4 ml at third CS, respectively. Figure 2 shows dense adhesions between the uterus and anterior abdominal wall in a woman who had had a CS.

Compared to those of primary CS, the incision–delivery interval (Fig. 3) and the operating time were also higher at repeat emergency and elective CSs (Table 4). There were small, but significant correlations found

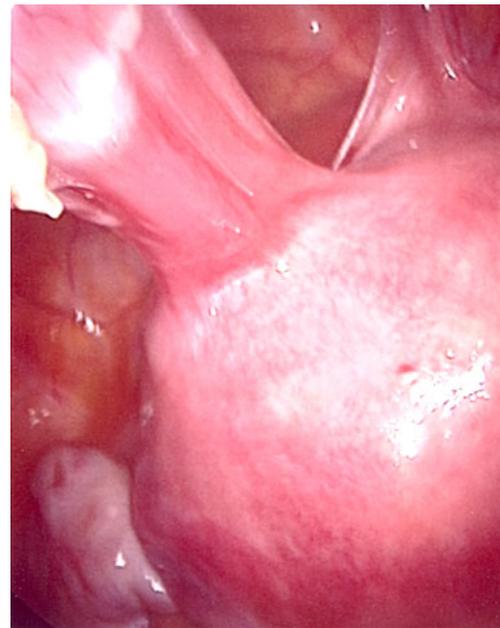


Fig. 2 Dense adhesions between the uterus and the anterior abdominal wall in a woman who had had a cesarean delivery

between the adhesion score and the interval between the incision and delivery ($r=0.23, P<0.0001$, Fig. 4) and the operating time ($r=0.26, P<0.0001$) in all cases. There was no significant difference in the Apgar score and in the fetal cord pH among those who had had primary CS, repeat one or repeat ≥2 CSs (all over 8.8 and 7.3, respectively). Furthermore, there was no correlation between the total adhesion score and fetal cord pH; among all women who underwent repeat CS as well as in those who underwent repeat emergency CS.

We encountered two intraoperative complications. One woman with placenta accreta underwent cesarean hysterectomy

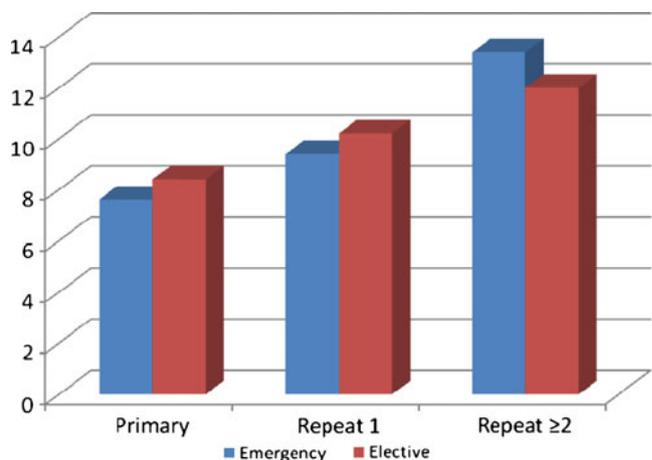


Fig. 3 Incision–delivery interval at repeat cesarean delivery for elective and emergency cases

Table 3 Adhesion score at repeat cesarean delivery (CS)

Site of adhesions	Repeat 1 CS	Repeat ≥2 CS	P value
Uterus–bladder	4.2±0.2	6.2±0.6	0.01
Uterus–abdominal wall	4.6±0.3	7.0±0.6	0.001
Uterus–intestine	3.5±0.5	4.9±1.4	NS
Uterus–omentum	3.8±0.3	4.3±0.8	NS

Table 4 Incision–delivery interval and operating time at repeat emergency and elective cesarean deliveries

	Primary (<i>n</i> =490)	Repeat 1 CS (<i>n</i> =430)	<i>P</i> value	Repeat≥2 CS (<i>n</i> =106)	<i>P</i> value
Emergency cesarean	345 (70.4%)	100 (23.3%)		18 (17%)	
Incision–delivery interval (min)	7.6±0.3	9.4±0.5	<0.001	13.4±1.8	<0.001
Operating time (min)	39.4±0.7	40.7±1.4	NS	46.2±2.9	<0.05
Elective cesarean	145 (29.6%)	330 (76.7%)		88 (83%)	
Incision–delivery interval (min)	8.4±0.3	10.2±0.3	0.002	12.01±0.6	0.0001
Operating time (min)	39.4±0.9	39.55±0.8	NS	45.0±1.6	0.005

tomy and another with severe adhesions suffered bowel injury at the third CS requiring segmental bowel resection.

Comment

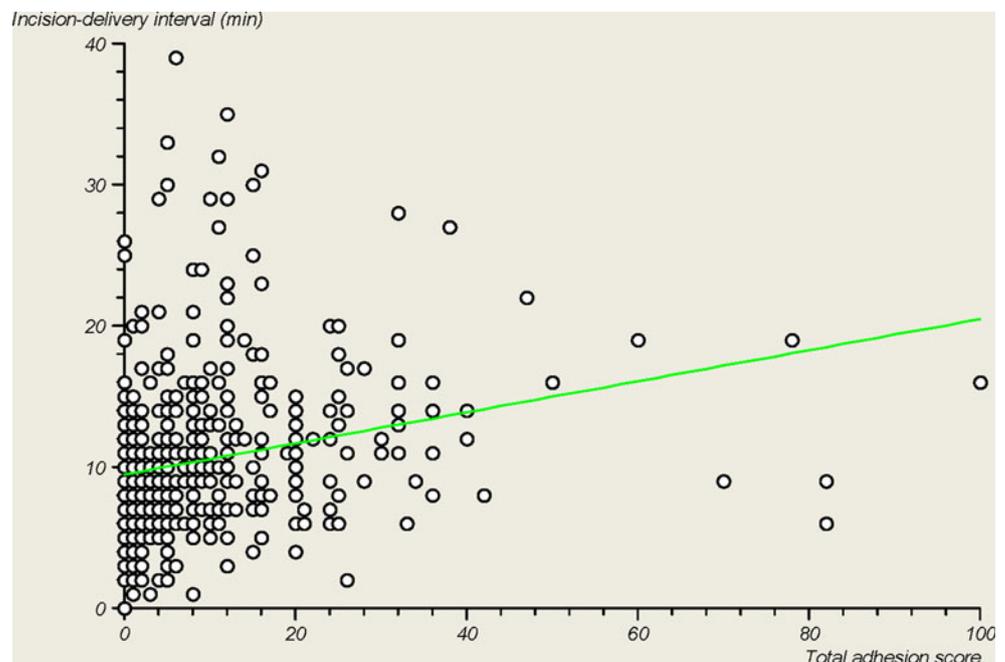
The results of our study showed that at repeat CS, adhesions were found mainly between the uterus and the bladder, and between the uterus and the anterior abdominal wall. This is in agreement with previous reports [3, 4]. Adhesions on these areas were also more severe after ≥2 CSs than after one cesarean. As previously suggested [3], it is very likely that the presence of these adhesions increases the incision–delivery interval delaying the birth of the newborn. In theory, it might be deleterious to the health of the baby. Yet in our series, we did not find any correlation between the total adhesion score and fetal cord pH. A much larger study is needed to clarify this matter. Besides increased incision–delivery interval, it also took longer to

complete surgery at repeat CS. Again, this is related to increased adhesion score.

Adhesions to the bladder might be associated with bladder injury at subsequent CS. The estimated incidence of bladder injury is about three to four per 1,000 repeat cesareans. Silver et al. found that the incidence of bladder laceration increased from 0.13% at a primary CS to 1.94% at the fifth CS [5]. No bladder injury was found in our series. Yet, we encountered adhesion-related bowel injury necessitating bowel resection. Bowel obstruction in the postpartum period due to post-cesarean adhesion has also been reported [6]. However, it usually occurs long after the initial surgery. The prevalence of bowel obstruction after CS has been estimated to be one per 1,000 cesareans [7].

Adhesions lead to a difficulty to perform subsequent CS as well as other abdominal operations. For example, Wang et al. reported higher rates of major complications in patients undergoing laparoscopic hysterectomy with previous CS; the higher the number of previous CS, the higher the rate

Fig. 4 Correlation between the adhesion score and the interval between the incision and delivery ($r=0.23$, $P<0.0001$)



of complications [8]. The most significant increase is seen in patients with more than two previous CS deliveries. Clearly, as previously reported morbidity increases with increasing number of deliveries [3–5, 9–11].

In attempts to decrease adhesion formation, several authors have evaluated different techniques of performing cesareans. In a chart review, a technique described at Misgav Ladach Hospital in Israel was associated with less intra-abdominal adhesions than the standard technique [12]. This non-conventional technique involves a transverse incision higher than the Pfannenstiel incision, and blunt separation of the rectus muscles, opening of the peritoneum as well as the uterine incision. The uterus is then closed with a one-layer continuous locking stitch. The visceral and parietal peritoneal layers are left unsutured. Whether, this technique is indeed associated with less adhesion formation remains unclear. In fact, two reports might contradict their assumption [13, 14]. Blumenfeld et al. reported that single layer closure of the hysterotomy incision was associated with more bladder adhesions at the time of repeat CS than double-layer closure [13]. There is also evidence that that non-closure of the peritoneum after cesarean section is associated with more adhesion formation compared to closure [14].

Our study has some limitations. Instead of relying on timed second-look laparoscopy, we evaluated adhesions at repeat cesarean delivery. A second-look procedure especially in postpartum women is inconvenient for new mothers and their baby, but would likely yield more accurate results. Our study was only from one center. While we have large volume in our practice, these results may not be fully applicable to other institutions with different practice patterns or techniques.

We conclude that cesarean delivery leads to adhesion formation mainly between the uterus and the bladder and between the uterus and the anterior abdominal wall. Repeat cesarean is associated with longer delivery and operating times due to the presence of adhesions.

Declaration of interest The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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