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MATERNAL-FETAL MEDICINE

Adhesions at repeat cesarean delivery: is there a personal impact?

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Abstract
Purpose The rise in the rate of cesarean deliveries highlights complications related to adhesion formation. This study evaluated whether the incidence and severity of adhesions secondary to repeat cesarean deliveries are a consequence of repeated surgeries or due to an individual's propensity to develop adhesions.
Methods A retrospective chart review was conducted for 160 patients who had more than two repeat cesarean deliveries in a single teaching hospital. Data regarding intra-abdominal adhesions were collected. The severity, location, density and amount of adhesions were evaluated based on standard operative reports. Adhesion progression in subsequent cesarean deliveries was evaluated for each individual patient.
Results 69/160 (43 %) patients developed significant adhesions following the primary cesarean delivery. Of these, 46 (67 %) had significant adhesions at the second surgery. Of the 91 (57 %) patients, who did not develop significant adhesions after the primary cesarean delivery, 34 (37 %) had significant adhesions at the third surgery. A patient presenting with significant adhesions at her second cesarean had a 1.88-fold risk for significant adhesions at her third cesarean (95 % CI 1.3–2.7).
Conclusions Our results suggest that adhesion development might be influenced by individual factors more than by the number of cesarean deliveries.

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Introduction

Cesarean delivery is the most commonly performed obstetric surgical procedure. It accounts for one-third of all deliveries in the USA. The increase in the rate of repeat cesareans has led to more difficult surgeries due to the formation of intra-abdominal adhesions [1]. The rate of adhesion formation has been reported as 24.4 % after the first and 42.8 % after the second cesarean delivery [2]. Other studies found even higher adhesion formation rates of up to 50 % after the primary cesarean delivery [3–5].

Intra-abdominal adhesions can complicate surgeries and prolong their duration. Consequently, perioperative complications such as surgical site infection and blood loss are increased [2, 4, 6]. Adhesions can also affect neonatal outcome, particularly in cases of emergency cesarean section. It has been shown that dense adhesions can increase the risk of umbilical cord artery pH below 7.1 and lower 5 min Apgar scores [7]. Bladder injury is another complication associated with adhesions, especially when they are located between the bladder and lower uterine segment [8, 9]. In addition, adhesions can cause late complications such as infertility, bowel obstruction and chronic pelvic pain [4].

Previous studies [1–5] examined various aspects associated with adhesion formation, in an attempt to find ways to decrease this complication. Suggested risk factors include an individual propensity, the number of cesarean sections and factors such as residual blood and postoperative infection [10].

Individual characteristics might be an important variable. Several factors were evaluated to predict the formation of intra-abdominal adhesions. It was assumed that because both scar and adhesion formation are healing processes controlled by inflammatory, hormonal and genetic factors, individuals have a personal propensity regarding adhesion formation. Previous studies found an association between scar characteristics, including keloid tissue, and dense intra-abdominal adhesions [11–13].

It is well established that the surgical technique affects patient outcomes. However, the effect of different surgical methods on adhesion formation, including the mode of closure of the abdominal layers, remains controversial [14–16].

There is no single, accepted, standardized method to assess and describe intra-abdominal adhesions. Previous researchers have used different scoring systems, some of which are complicated and therefore suffer from potential recall bias. Adhesions have been evaluated by site and involvement of adjacent organs (bladder, intestine and omentum), by the ability to separate them bluntly or with sharp dissection (scissors) or by surgeons' estimation of severity (flimsy to cohesive) and extent (percentage of area covered or length of adhesion) of adhesions at different abdominal sites [5, 13, 17–20].

Previous studies have shown an association between the number of cesarean sections and the severity of adhesions [2, 21]. However, to the best of our knowledge, there are no published data regarding the tendency to develop adhesions based on an analysis of sequential cesarean deliveries in the same patient. This study evaluated whether the incidence and severity of adhesions at repeat cesarean deliveries were due to an individual propensity to develop adhesions or a consequence of repeated surgeries.

Materials and methods

A retrospective chart review was conducted for patients who had more than one consecutive cesarean section at our institution during the years 2006 through 2012. Inclusion criteria for the study were at least three cesarean deliveries at our institution and availability of structured, computerized operative notes.

Exclusion criteria were a history of other abdominal or pelvic surgery or cesarean deliveries performed with a classic or T incision. Patients with a history of abdominal or pelvic inflammatory diseases were also excluded, as well as patients who were chronically treated with steroids for any reason. Women were excluded from the original study if, on record review, they were found to have had adhesions during the primary cesarean delivery. Women with insulin-dependent diabetes mellitus or steroid-dependent disease were also excluded.

For each participant, the following data were retrieved from the computerized medical records: maternal age, gestational age, ethnicity, body mass index (BMI), history of chronic illness, indication for surgery, interval between cesarean deliveries, operative setting (elective/urgent), post- and intraoperative complications (including infections) and the description of the adhesions in the operative note. Adhesions were classified as significant or non-significant based on the criteria described in Table 1. The table that was used to categorize the adhesions, Table 1, was created based on the structured sentences in the postoperative notes. We copied sentences from the computerized structured notes to ensure uniformity, as these were the sentences used by the surgeons. We divided them into significant versus non-significant based on their interference with the abdominal anatomy and the difficulty to deliver a fetus.

Given that there is no standardized method to assess adhesions, we used parameters that were previously incorporated into other scoring systems [5, 13, 17–20] and modified them to fit our computerized operative notes. This enabled us to improve the quality of the data, despite the retrospective nature of the study. Importantly, since the study was held at a teaching hospital, all cesarean deliveries were performed using a uniform surgical technique. The majority of the cases were performed by residents, assisted by senior staff physicians. Computerized operative notes were written immediately after the surgery was completed. These structured notes include categorical information regarding the severity, location, density and amount of adhesions of each patient. The surgeon marks specific structured sentences and incorporate them into the postoperative note. We opted to use these data as objective, uniform and prospectively collected. Adhesions were classified as significant or non-significant according to their location and density (Table 1). For each patient, the progression of adhesions in subsequent cesarean sections was evaluated and compared to the adhesion status at the previous cesarean delivery.

Data analysis was performed using the SPSS 19.0® computer package. Data concerning normally distributed continuous variables were analyzed with an unpaired *t* test. Chi-square or Fisher's exact test was used for comparisons of rates and proportions. Multivariate analysis was carried out using general linear models. All *P* values were tested as two sided and considered significant at <0.05.

This study was approved by the local institutional review board.

Results

During the time of the study, there were about 33,000 deliveries in our institution, among which 19 % had a cesarean delivery. A total of 160 patients who had two subsequent cesarean deliveries were included in the study. Demographic, pregnancy and delivery characteristics did not differ between women with and without significant adhesions after the primary surgery (Table 2). We analyzed the same parameters also for patients with and without significant adhesions after the second cesarean delivery and could not detect any significant difference between the groups with similar findings to those presented in Table 2.

Most of the primary cesarean deliveries were urgent and most of the repeat cesarean deliveries were elective surgeries. Non-reassuring fetal heart rate was the most common indication for the first cesarean delivery, whereas the most common indication for second cesarean delivery was the woman's preference or an indication for a delivery before the onset of labor (our department does not induce patients with a uterine scar) (Table 3). All third cesarean deliveries were elective according to departmental policy.

Significant adhesion formation was reported in 69 (43 %) and non-significant adhesions were reported in 91 (57 %) patients at the second operation. Of the patients with significant adhesions at the second operation, 46 (67 %) demonstrated significant adhesions after a subsequent surgery. Of the 91 (57 %) patients who did not develop significant adhesions after the primary cesarean delivery, 34 (37 %) developed significant intra-abdominal adhesions after the second surgery (Fig. 1).

We could not detect any correlation between the indications for the prior cesarean delivery to the type or amount of adhesions detected during the following surgery.

Based on our data, a patient who had no adhesions after a single operation has a 62.6 % likelihood of not developing significant adhesions ($P < 0.05$). Based on the relative risk analysis for adhesions, a patient presenting with significant adhesions at her second cesarean delivery has a 1.88-fold risk for significant adhesions at her third cesarean delivery (95 % CI 1.3–2.7).

Table 1 Categorization of adhesions

Significant adhesions	Non-significant adhesions
Omentum to peritoneum	No adhesions
Omentum to uterus	Skin to fascia
Dense adhesions in the lower uterine segment	Fascia to muscle
Adhesions of adjacent organs to uterus	Filmy adhesions in the lower uterine segment
Inability to extract the uterus	

Table 2 Patient characteristics according to adhesion significance after the primary cesarean section

Variable	Significant adhesions 69 (43 %)	Non-significant adhesions 91 (57 %)	*P* value
Mean BMI (kg/m^2 ± SD)	27.6 ± 5.3	25.4 ± 4.2	0.3
Mean maternal age (years ± SD)	29.6 ± 4.3	30.7 ± 3.8	0.11
Mean gestational age (weeks ± SD)	38.6 ± 2.7	38.7 ± 3.6	0.82
Parity (%)			0.3
Primiparous	64 (92.7)	78 (85.7)	
Multiparous	5 (7.2)	13 (14.3)	
Pregnancy complications (preeclampsia, gestational diabetes, placental abruption) (%)	7 (10.1)	5 (5.49)	0.3
Primary surgery (%)			0.56
Urgent	57 (82.6)	69 (75.8)	
Elective	12 (17.4)	22 (24.2)	
Infection during the course of the primary surgery (%)	3 (4.34)	3 (3.29)	0.74

Discussion

The findings of this study indicate that a woman who does not have significant adhesion formation after the first cesarean delivery has a lower likelihood of developing significant adhesions at subsequent cesarean deliveries, compared to a women who developed significant adhesions after the primary cesarean delivery. In addition, it seems that some women have a tendency toward adhesion formation, which will manifest after a single cesarean delivery (discovered at their second operation). These women have a high probability for significant adhesions at subsequent surgeries.

Some data support the assumption that adhesions worsen with increasing numbers of cesarean sections [2]. Major surgical complications, such as cesarean hysterectomy, blood transfusion and longer hospitalizations were reported with increasing numbers of cesareans and were related to adhesions [22]. Uygur et al. [21] found that patients with two or more previous cesarean deliveries had significantly more dense adhesions compared to patients with one previous delivery. Those studies compared patients grouped by the number of surgeries they underwent. The novelty of the current study is the ability to look at adhesion progression in the same patient over time as she underwent an increasing number of cesarean procedures.

Table 3 Indications for cesarean section in the first and the second deliveries

Indication	Primary cesarean *N* (%)	Second cesarean *N* (%)
Patient requested repeat cesarean section	0	100 (62.5)
Non-reassuring fetal heart rate	52 (32.5)	15 (9.3)
First or second-stage labor disorder	45 (28.1)	10 (6.25)
Macrosomia	8 (5.3)	11 (6.8)
Non-vertex presentation	34 (21.2)	9 (5.6)
Maternal indication	12 (7.5)	3 (1.8)
Contraindication for vaginal delivery	5 (3.1)	5 (3.1)
Placental abruption	4 (2.5)	5 (3.1)

The likelihood of an individual's propensity to form adhesions is supported by data that showed that women with keloid scars are prone to develop adhesions. Excess production and deposition of extracellular matrix might play a central role in the formation of adhesions and keloids and might be controlled by variations in gene expression [12]. Similarly, Stocker observed that skin scar characteristics were associated with the presence and degree of pelvic adhesions [13]. While Salim et al. [11] did not find significant differences in the incidence of intra-abdominal adhesions between women after a single operation, compared to those who had two or more cesarean deliveries, they found that a depressed scar on the skin correlated with dense intra-abdominal adhesions. These data, which support individual propensity as the primary factor in adhesion formation, are consistent with the results of the current study.

Adhesions have been correlated to surgical technique. While peritoneal closure revealed contradictory results, closure of the rectus muscles at cesarean delivery may reduce adhesions [5, 17, 19, 23]. Those who support peritoneal and rectal muscle closure claim that it provides an anatomic barrier, reduces wound dehiscence and minimizes adhesions; those who are against closure support their position on observations of no difference in adhesion formation and on the fact that no long-term benefits were found for peritoneal closure [1, 14–16]. Recently, a prospective randomized trial of 533 women who underwent primary cesarean delivery failed to detect a difference in terms of adhesions between closure and non-closure of the peritoneum at cesarean delivery [19].

The potential confounding effect of other surgical techniques has not been fully evaluated. Bladder flap formation during a repeat cesarean delivery and single-layer hysterotomy closure may be associated with more frequent adhesions during repeat cesarean deliveries [18, 24]. Moreover, reduced adhesion formation using an absorbable adhesion barrier has been reported [20].

Several grading methods have been suggested to evaluate the organs involved with the adhesions, the ability to separate the adhesions (bluntly or by sharp dissection) [13, 19, 23] and the surgeon's impression of the adhesions as being film or dense [11, 12, 19, 25]. In this study, we categorized the adhesions as significant or non-significant

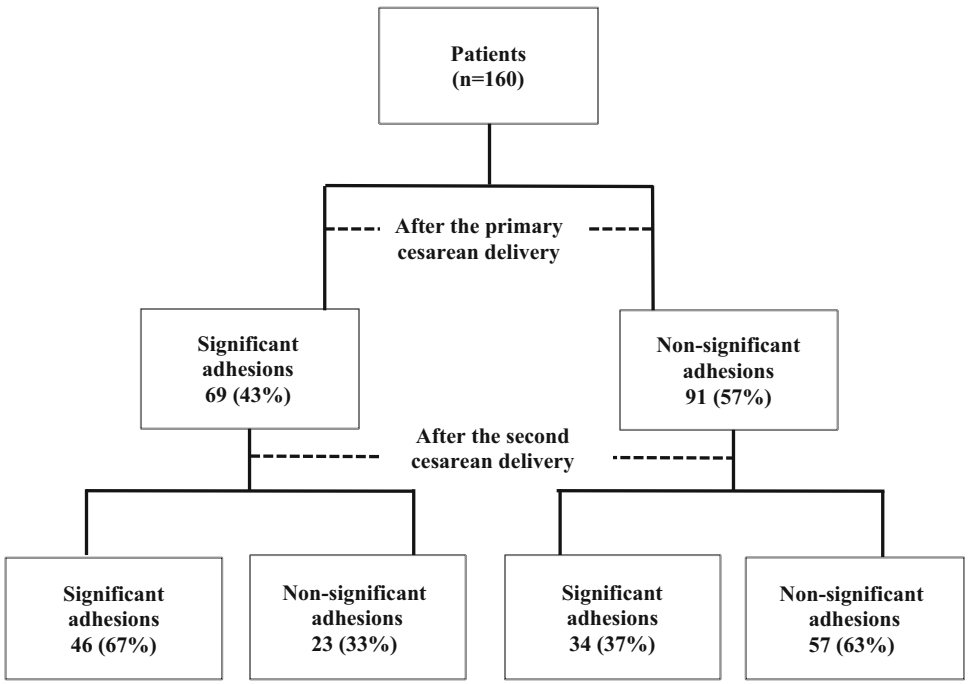

Fig. 1 Adhesion formation through repeated cesarean deliveries

based on previously described parameters. We simplified previously described scoring systems to increase the accuracy of grading our retrospective data. Significant adhesions were defined according to their location, in relation to the uterus and the omentum or adjacent organs, as adhesions preventing exteriorization of the uterus during surgery or dense adhesions in the lower uterine segment. The present study might be affected by inter- and intra-observer variability. Adhesion grading and descriptions were dependent on the surgeon's impression and completely uniform evaluation was not possible. Previous studies regarding adhesions and cesarean deliveries encountered the same problem.

The strength of this study is that all the cesarean deliveries were conducted with a uniform technique according to departmental protocol. The peritoneum was never closed and the rectus muscles were not sutured, which eliminated potential confounding effects of different surgical techniques.

An additional strength of the study is the large sample of patients who had a subsequent cesarean delivery at our institution during the study period, and hence the ability to have follow-up on a large group of women with repeated cesarean deliveries and to compare each patient to herself, to study the propensity toward adhesion formation.

Another point to consider is that our study examined the first three sequential cesarean deliveries. It is possible that after a certain number of cesarean deliveries, the number of surgeries has equal or greater importance in adhesion formation than the individual tendency.

The study is limited by its retrospective design, although the structured, uniform operative reports that incorporate detailed adhesion information were completed immediately after surgery and increased the reliability of the data. Another factor that could potentially affect adhesion formation is the surgeon. The study took place in a teaching hospital. Therefore, even when a resident performed the surgery, the physician who was responsible for the cesarean section was always an attending physician who corrected the residents and guided them according to the department's protocols. Unfortunately, the nature of our study could not allow us to study the correlation between the residents' need for attending's intervention throughout the surgery and adhesion formation.

Since adhesions might have a critical effect on the course of a cesarean delivery and its outcomes, understanding possible reasons for their development is clinically significant.

As the rate of cesarean deliveries rises, counseling women with repeated cesarean sections has become a frequent necessity. Individual propensity appears to be the crucial factor in the formation of adhesions. However, these results do not exclude the increased risk of adhesions with increased number of surgeries. Specific influencing factors on the formation of adhesions in our study population were not identified. Additional studies with larger samples are needed to determine factors affecting an individual's propensity to develop adhesions or not.

The ability to evaluate risk factors for the development of significant adhesions will allow us to look for possible preventative methods. It will enable women to receive appropriate counseling before a subsequent cesarean delivery and the medical staff to prepare for the procedure.

Conflict of interest The authors do not have any conflict of interest.

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