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Can We Predict the Presence and Severity of Intra-Abdominal Adhesions before Cesarean Delivery?

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Key Words
Adhesion · Cesarean delivery · Skin scar · Symptoms

Abstract
Aims: The study aimed to investigate whether we can predict the presence and severity of intra-abdominal adhesions before cesarean delivery using patient history, symptoms, and abdominal skin scar characteristics. ***Methods:*** In this prospective study, 143 pregnant women with history of previous abdominal surgery were included and they delivered by cesarean. Preoperative abdominal scar characteristics and symptoms as well as intraoperative abdominal adhesions were evaluated using the Manchester Scar Scale, a symptomatology questionnaire and the More Comprehensive Adhesion Scoring Method, respectively. ***Results:*** Patients with adhesions ($n = 98$) and without adhesions ($n = 45$) had similar baseline characteristics. In the adhesion group, abdominal scar scoring parameters were significantly increased. However, there was no significant correlation among total scar score, adhesion score, and symptom score. ***Conclusion:*** Despite the availability of many proposed methods, accurate prediction of the severity of surgery-related adhesions is beyond our current abilities. Therefore, as healthcare providers, obstetricians should avoid unnecessary use of the cesarean approach. This approach is more effective, beneficial, realizable, and reasonable than the prediction of surgery-related adhesions.

Introduction

Cesarean delivery (CD) is the most widely performed obstetric surgery, and the rate at which CD is performed is increasing rapidly. In the United States, 1 in 3 women gave birth by CD in 2011; higher rates of CD are reported in developing countries, with an incidence of 40% in 2008 [1, 2]. Although CD is frequently performed as per fetal indications, it can also result in various severe maternal and fetal complications in comparison to vaginal delivery, including severe hemorrhage, shock, cardiac arrest, fetal loss, major infections, venous thromboembolism, uterine rupture, and hysterectomy [3]. Additionally, one of the most important complications of CD is intra-abdominal adhesions.

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Adhesions, which are abnormal bonds between the surfaces of anatomical structures, can present with varying severity after repeated intra-abdominal or pelvic surgeries. The consequences of these pathological bonds include bowel obstruction, chronic abdominal and pelvic pain, the need for re-intervention, ectopic pregnancy, infertility, and inadvertent organ injury or loss during surgery [4].

Despite the absence of a reliable noninvasive method for identifying intra-abdominal adhesions preoperatively, several authors have proposed abdominal scar features as a possible predictor for the presence and severity of adhesions [5–7].

As a consequence of the potentially severe complications of CD and the associated morbidity, we aimed to investigate whether the presence and severity of intra-abdominal adhesions can be predicted preoperatively using a 4-step evaluation process based on abdominal scar characteristics and associated symptoms.

Materials and Methods

This prospective cohort study was conducted at a tertiary referral center at the Ege University Hospital during the period from January 2015 to June 2015. A total of 143 patients who had undergone at least one previous abdominal surgery including laparoscopy, laparotomy, or CD were scheduled for elective CD and included in the study. Patients with systemic inflammatory and vascular diseases such as infections, including wound infections (which may alter scar formation), diabetes, endometriosis, systemic lupus erythematosus, and other types of vasculitis that can affect the nature of wound healing were excluded. Following a detailed explanation of the aims of the study, informed consent was obtained from all participants. The Ethics Committee of Ege University Hospital approved the study (reference number 14-4/4).

All patients were evaluated with a 4-step algorithm. Each step was performed by different researchers who were not informed about other assessment scores, in order to avoid bias.

The first step consisted of patient history; age, parity, body mass index, smoking, and history of previous surgeries (number and type of operations, and time since the last operation) were evaluated. As all patients were Caucasian, ethnicity was excluded from the study parameters. Additionally, full blood count results of all patients were recorded. The second step was performed by another member of the research team questioning the symptoms, which could be related with abdominal adhesions. All patients were asked about the frequency of chronic or intermittent pelvic pain, urogenital symptoms (dyspareunia, pollakiuria, urinary retention, recurrent vaginal infection, and pelvic inflammatory disease [PID]), and gastrointestinal symptoms (constipation and bloating) since the last surgery. Symptoms were rated numerically from 0 to 3 according to severity.

As the third step of the process, abdominal scar assessment was performed in the operating room while the patient was anesthetized, lying in the supine position under a standard operating light source that was focused on the abdomen. Another member of the team evaluated the abdominal scars of all subjects using the Manchester External Scar Scale and recorded photographic evidence of all scars. This scoring system was successfully applied for a wide scale of scars and consists of significant descriptors, which were correlated to histological score [8]. If there were multiple abdominal scars, the researcher included the scar with highest score for statistical analysis.

At the final step, the operating surgeon, who was not informed about the previous steps, evaluated all patients for intra-abdominal adhesions using the More Comprehensive Adhesion Scoring Method (min–max scores: 0–138) [9]. Twenty-three anatomical sites inside the abdominopelvic cavity were examined and assessed for the presence, severity (0 = none, 1 = filmy/avascular, 2 = some vascularity and/or dense, and 3 = cohesive), and extent (0 = none, 1 = coverage <26%, 2 = coverage 26–50%, and 3 = coverage >50%) of the adhesions. Based on their intraoperative total adhesion scores, patients were categorized in to 2 groups as with or without adhesion, that is, 0 or ≤1, respectively.

Ultimately, all collected data were analyzed using SPSS statistical software package version 17.0 (Chicago, IL, USA). The normality assumption for the continuous responses was checked using the Shapiro–Wilk test, and the homogeneity of variances was controlled with Levene test. Student *t* test and Mann–Whitney U test were used as parametric and non-parametric tests, respectively, for comparing the differences between 2 groups. Fisher exact test and chi-square test were used to assess the differences of categorical parameters. Bivariate correlations were analyzed by Pearson correlation coefficient test or Spearman's rank correlation test. Monte Carlo Simulation Method was used when expected frequencies were lower than 20%. We assumed an aberrant pattern of scarring in 60% of women with adhesions according to the study published after assessment of scars after cesarean deliveries by Salim et al. [5]. Our power analysis was done with beta and alpha errors of 0.2 and 0.05, respectively. The assumed rate of adhesions was 35% in low scar score, compared with 65% in those with a higher scar score. Based on these parameters, we calculated that at least 100 patients would be included in the study. Significance was set at $p < 0.05$ and data were represented as mean ± SD.

Results

The preoperative patient characteristics and blood count results are shown in Table 1. Smoking rate, number of previous operations, and neutrophil fraction were significantly higher in patients with intra-abdominal adhesions.

Comparison of preoperative symptom assessment of patients with and without intra-abdominal adhesions is demonstrated in Table 2. The most common symptoms were recurrent vaginal infection (26.5 vs. 20%) and pelvic pain (22.4 vs. 15.5%). However, there was significant difference between the 2 groups in their expression of pelvic pain and PID, which was more predominant in patients with adhesions.

Table 1. Preoperative patient characteristics and laboratory findings

Parameters	Adhesion (n = 98)	No adhesion (n = 45)	p value
Age, years	30.3±5.1	29.1±5.5	0.18
Body mass index, kg/m^2	30.1±4.4	30.1±4.9	0.5
Smoking, % (n)	25.5 (25)	11.1 (5)	0.04
Number of previous operations	2 (1–5)	1 (1–3)	0.001
Cesarean	1.7±1	1±0.4	0.001
Laparotomy	0.1±0.3	0.1±0.4	0.5
Laparoscopy	0.05±0.2	0.6±0.2	0.7
Time since last operation, years	5.2±3.3	4.9±3	0.6
Blood count			
Hemoglobin, g/dL	11.2±1.5	11.4±1	0.4
Hematocrit, fraction%	33.3±3.8	33.9±2.8	0.3
Leucocytes, count/mm^3	9,643.9±2,901	9,391.7±2,696	0.6
Neutrophils, fraction%	72.4±6.2	69.3±5.6	0.005
Monocytes, fraction%	4±1.2	6.7±1.7	0.5
Platelets, count/mm^3	153,580±20,500	156,040±18,400	0.6

Data shown as mean ± SD, median (range), or percentage and $p < 0.05$.

Table 2. Preoperative symptom severity scores of patients

Parameters	Adhesion (n = 98)	No adhesion (n = 45)	p value
Constipation	0.2±0.5	0.1±0.5	0.7
Bloating	0.2±0.5	0.08±0.4	0.1
Pelvic pain	0.4±0.6	0.1±0.3	0.002
Vaginitis*	0.3±0.5	0.2±0.4	0.1
PID	0.1±0.4	0.02±0.1	0.009
Dysparonia	0.1±0.3	0.04±0.2	0.1
Pollakiuria	0.2±0.5	0.08±0.3	0.1
Urinary retention	0.1±0.4	0.08±0.2	0.6

Data shown as mean ± SD and $p < 0.05$. Symptoms scored as 0: none, 1: mild, 2: moderate, and 3: severe.
* Recurrent vaginal infection defined as more than 4 infections per year.

Abdominal scar characteristics were preoperatively assessed for all patients using the Manchester Scar Scale. The records are presented in Table 3. Total scar scores with parameters of color, appearance, contour, and distortion were significantly increased in patients with abdominal adhesions. In addition, color was the most significantly increased scar parameter in patients with abdominal adhesions ($p < 0.01$).

In patients with intra-abdominal adhesions, mean adhesion score was 20.3 ± 13.1 (range 4–55). The most common locations for adhesions were observed to involve bladder (76.5%), anterior uterine surface (74.4%), omentum (66.3%), and caudal part of anterior abdominal wall (65.3%). Total adhesion score was found to increase with number of previous operations; however, severity of adhesions did not show similar correlation.

Analysis of correlations between preoperative symptom score, abdominal scar score, and abdominal adhesion score showed no statistically significant correlation either between symptoms and adhesion score or between scar score and adhesion score (Table 4). However, there was a statistically significant correlation between symptom score and scar score with a low importance rate of 18.4% ($p < 0.05$).

Table 3. Preoperative skin scar characteristics of patients

Parameters	Adhesion (n = 98)	No adhesion (n = 45)	p value
Color			0.001
Perfect	24.4 (24)	44.4 (20)	
Slight mismatch	53 (52)	48.8 (22)	
Obvious mismatch	18.3 (18)	6.6 (3)	
Gross mismatch	4 (4)	0 (0)	
Appearance			0.04
Matte	58.1 (57)	75.5 (34)	
Shiny	41.8 (41)	24.4 (11)	
Contour			0.01
Flush with surrounding skin	54.2 (53)	71.1 (32)	
Slightly proud/indented	40.8 (40)	2 (9)	
Hypertrophic	3 (3)	8.8 (4)	
Keloid	2 (2)	0 (0)	
Distortion			0.03
None	40.8 (40)	75.5 (34)	
Mild	41.8 (41)	17.7 (8)	
Moderate	15.4 (15)	6.6 (3)	
Severe	2 (2)	0 (0)	
Texture			0.09
Normal	57.1 (56)	71.1 (32)	
Just palpable	39.7 (39)	24.4 (11)	
Firm	0 (0)	2.2 (1)	
Hard	3 (3)	2.2 (1)	
Total score	8 (5–18)	6 (5–14)	0.002

Data shown as percentage (number) or median (range) and $p < 0.05$.

Discussion

Increasing rates of CD, without concomitant improvement in maternal and fetal mortality and morbidity, is a global concern [1–3]. Repeated CDs have been reported to progressively increase serious maternal complications including higher rates of hemorrhage, uterine rupture, surgical injury, adhesions, and hysterectomy [4–6]. Maternal morbidity is markedly raised from 15 to 83% due to the presence of placenta previa and placenta accreta, which increased significantly with repeated CDs compared to vaginal delivery [10]. Multiple CDs are also associated with an increased risk of cystotomy, ureteral injury, bowel injury, ileus, and intensive care unit admission [11]. Increasing numbers of CD are not only associated with maternal morbidity but also with perinatal complications such as stillbirth, preterm birth, and fetuses of small size for gestational age [11, 12]. In addition, spontaneous abortion and cesarean scar ectopic pregnancies are important concerns that should be noted [13].

Several studies have demonstrated that CD is associated with a high risk of adhesion development mostly between the uterus and surrounding organs [14]. The presence and severity of adhesions have been reported to increase with increasing number of CD. After the first cesarean section and a third cesarean section, the incidences of adhesions were reported as 46 and 75%, respectively [15]. Although the incidence of adhesions is lower at primary CD in comparison to gynecological surgeries,

Table 4. Correlation analysis between scores of preoperative symptoms, skin scar, and adhesion

	Adhesion score	Skin scar score
Symptomatology score		
r	0.047	0.184
p	0.647	0.049*
n	98	98
Skin scar score		
r	0.056	
p	0.584	
n	98	

* $p < 0.05$.

the percentage of women with adhesions increases with each subsequent CD [16]. Besides many severe complications caused by adhesions, treatment procedures of adhesiolysis accounted for $1.3 billion of healthcare costs in 1994 in the United States [17].

Abdominal adhesions are pathological band-like structures that form between organ surfaces as an inflammatory response after surgery, infection, or chemical irritation. After surgical trauma, the wound healing process of peritoneal tissue involves a very complex mechanism consisting of inflammatory cells, cytokines, coagulation molecules, and fibrin deposition [18]. An imbalance in this complex molecular and cellular process results in adhesion formation starting immediately after the surgery. Infection, tissue ischemia, tissue desiccation, intraperitoneal blood, and reactive foreign bodies (such as talc powder from gloves and sutures) have been reported as being common risk factors [19]. Surgical technique, genetic factors, white blood cells, and fibroblast activities are also proposed as risk factors in adhesion development [20, 21].

As a consequence of many concerns associated with adhesions, researchers are probing underlying reasons and trying to find proper and available methods to predict and decrease adhesion-related complications. In this study, we aimed to reveal whether we could predict the presence and severity of abdominal adhesions before CD by using simple and practical assessment methods that can be easily performed by every obstetrician rather than hard-to-reach and elusive techniques.

Recently, some authors suggested abdominal scar characteristics as a possible predictor for severity of intra-abdominal adhesions proposing the similarities in healing of skin and peritoneum. In 2 similar studies published by Salim et al. [5] and Kahyaoglu et al. [6], depressed abdominal scars were reported as being associated with intra-abdominal adhesions. Stocker et al. [7], using more detailed scoring methods, suggested that patients with a palpable scar were most likely to have pelvic adhesions.

However, an important point to ponder is that peritoneal wound healing occurs over the whole surface unlike skin and other tissues, which heals from the edges of disrupted epithelium [22, 23]. This fundamental difference of healing behavior breaks the estimated similarity in response to injury. We have found higher abdominal scar scores in patients with abdominal adhesions but there was no statistically significant correlation between abdominal scar score and abdominal adhesion score. Even so, further trials with larger numbers are needed to investigate this issue.

Preoperative fraction of blood neutrophils, which are crucial cellular players in adhesion formation, was significantly increased in patients with adhesions [24, 25]. However, the same difference was not detected for other cellular components.

According to assessment of adhesion-related symptoms, pelvic pain is the most commonly reported complaint [26]. In addition to pelvic pain, considering adhesions can disrupt the functions of pelvic organs, we also investigated other suspected symptoms such as constipation, bloating, dyspareunia, recurrent vaginal infection, PID, pollakiuria, and urinary retention. However, there was no correlation between preoperative symptom score and adhesion score.

In conclusion, this study showed that despite many proposed methods, accurately predicting the severity of surgery-related adhesions remains beyond our current abilities. Although certain imaging methods such as transabdominal and transvaginal ultrasonography, visceral slide, and cine MRI are suggested as feasible methods for identifying intra-abdominal adhesions (with accuracy of 76–92%), all reported studies were non-blinded, and none of them included pregnant patients. This is important because pregnant women have altered abdominal anatomy due to the growing uterus [27]. These methods are also commonly applied for imaging the upper abdominal segment and abdominal wall, which are far from the essential spaces of the pelvic cavity and lower abdominal segment typically operated upon during obstetric surgery. Therefore, as healthcare providers, obstetricians should aim to prevent unnecessary CD surgery. This approach is more effective, beneficial, realizable, and reasonable than the prediction of surgery-related adhesions.

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Disclosure Statement

All authors declare that there is no conflict of interest.

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