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Previous Cesarean Scar Characteristics May Predict Severity of Intraperitoneal Adhesions: A Prospective Cross-Sectional Study

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ABSTRACT

Objective: Similar to other intra-abdominal operations, previous cesarean section (CS) is associated with intra-peritoneal adhesion (IPA) formation which can cause complications and morbidity during repeat CS. IPA and scar formation are related to the individual healing process. The aim of this study is to find out if previous cesarean scar characteristics could predict the presence and degree of IPA at repeat cesarean delivery.

Materials and Methods: Previous CS incision scar characteristics (length, width, pigmentation, and morphology) and the lower abdominal sag of pregnant women meeting the study criteria were evaluated before the operation. During the repeat CS, IPA presence and severity were evaluated and scored according to the clinical adhesion scoring system.

Results: IPA severity was significantly related to the previous scar width and degree of abdominal sagging.

Conclusions: Evaluation of scar characteristics and abdominal sag before laparotomy could help the surgeon to predict the presence and severity of IPA and to prepare preoperatively for possible complications.

KEYWORDS
Cesarean; intraperitoneal adhesion; scar; abdominal sagging.

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Introduction

Cesarean section (CS) is one of the most common surgical procedures with short and long term risks and consequences[1,2]. The rate of cesarean delivery has increased almost 6 times in 4 decades in the US rising from 5.5% in 1970 to 32.2% in 2014[3,4]. In Turkey, this ratio was 52% in 2018[5]. About 60% of CS deliveries are primary, the other 40% are repeat cesareans. Each repeat CS is generally more complicated than the last. The high rate of cesarean delivery and the declining rate of vaginal birth after CS make it mandatory to be aware of the potential complications that are associated with repeat CS[6].

Similar to other intra-abdominal operations, CS is associated with intra-peritoneal adhesion (IPA) formation. These adhesions may cause significant morbidity and to a lesser extend mortality, difficulty in entering the abdominal cavity during surgery, longer time to deliver the baby during repeat cesarean, increased risk of bowel/ bladder/organ injury, bleeding, increased operative time and hospital stay[7-11]. Even optimal surgical techniques cannot prevent adhesion formation completely. Prediction of IPAs before performing laparotomy is important for preoperative preparation of the surgical team for possible surgical risks and selection of suitable anesthesia. Unfortunately, currently, there is no reliable way to predict the exact severity of IPA preoperatively.

Surgical incisions do not heal uniformly. The skin and tissue characteristics of an individual person in addition to surgical techniques influence the healing process and speed. The healing process may be different even in the same person undergoing different operations. Differences in wound healing and tissue quality could influence scar characteristics and IPA formation. Incisional scar formation and tissue contraction at the fascia level after CS can cause sagging of the skin at the anterior abdominal wall below the umbilicus. Some externally recognized differences in the healing process at the incisional site and abdominal sagging might demonstrate the intraabdominal healing process indirectly and the presence/ severity of IPA.

In this study incisional scar characteristics together with anterior abdominal skin prolapse (abdominal sagging) were evaluated in cases with previous CS to find if these parameters have any value in predicting IPAs at repeat cesarean delivery. Our hypothesis is that scar characteristics might predict adhesion presence and severity prior to surgery.

Material and Methods

This prospective cross-sectional study was conducted between December 2011 and June 2015 in Nene Hatun Gynecology and Obstetrics Hospital, Erzurum, Türkiye. Three hundred eighty-nine pregnant women who met study criteria were included in the study. The inclusion criteria were low risk singleton pregnant women of at least 36 weeks' gestation with at least one prior cesarean delivery and post-partum care in the same hospital. Pregnant women with systemic disease, a previous midline skin incision, those who underwent any abdominal surgery other than CS, those using corticosteroids, those who smoke, or those having a history of previous pelvic inflammatory disease or previous surgical site infection after delivery were excluded from the study.

Demographic parameters of cases (age, gravidity, parity, gestational age at delivery, body mass index (BMI), weight gain, CS urgency (elective/emergent), number of prior CS delivery) and preoperative hemoglobin levels were recorded. During the last week before the operation, the previous cesarean scar was evaluated for length, width, morphology and pigmentation. Length and width were measured with a plastic ruler and recorded. For morphological evaluation incisional scars were

divided into three groups based on the level of the scar in relation to the surrounding skin as: flat, depressed and elevated. The pigmentation status of the scar was determined as darker, the same or lighter relative to the neighboring skin.

For the calculation of the degree of lower abdominal sag, we used a new method that we developed ourselves. In this method, the distance between the symphsis pubis and umbilicus (S-U) was measured in a neutral and a streched position with a tape in the Semi-Fowler's position. The difference between the two measuments was utilized to determine the amount of abdominal sagging.

All patients underwent a CS by the modified Joel-Cohen technique, which includes blunt separation of tissues along natural tissue planes with a minimum of sharp dissection and non-closure of both layers of the peritoneum. A low segment transverse incision was made in the uterus in all cases and the fetus was delivered. The placenta was allowed to separate spontaneously unless there was a placental adhesion abnormality. After bleeding control, the uterine incision was closed by no. 1.0 polyglycolic acid in a single layer continuous locking suture. The evaluation of IPA was then done. Adhesions were scored according to the clinical adhesion scoring system of Linsky et al[12]. The adhesion area was classified into three grades, as: grade 1, none or filmy, avascular, ≤25% of area; grade 2, dense or vascular, 25-50% of area; and grade 3, dense and vascular, 50-100% of area. After scoring the IPA and performing adhesiolysis if required, the fascia was closed continuously by no. 1.0 polyglycolic acid sutures. The skin was reapproximated subcutaneously by no. 3.0 polyglactin 910. Neonatal weight was recorded.

Statistical Analysis

Power analysis of the study showed that a total of 343 patients was needed to gain 80% power when the alpha error was set at 0.05, the beta error at 0.20 and the effect size at 0.15. The statistical analyses were conducted using the SPSS 15.0 statistical software package (SPSS Inc., Chicago, II, USA). Groups were controlled in terms of conformity to normal distribution by graphical check and the Shapiro Wilk test. In presenting descriptive statistics, numbers and percentages were used for categorical variables, and median [interquartile range (IQR) (minimum-maximum)] values were used for the continuous data. The Chi-square test was used for the comparison of categorical variables. The Kruskal Wallis test and the Bonferroni corrected Mann-Whitney test were used to compare the data that were not distributed normally. Spearman's correlation analysis was used for determination of parameters that can affect adhesion scores. Ordinal logistic regression analysis was used to find independent predictors of the presence and severity of IPAs. A P-value < 0.05 was considered significant.

Ethics

Approval for this study was obtained from the Local Institutional Review Board of the Faculty of Medicine, Turgut Özal University (No: B-302FSH0200000-2491, Date: Dec 08, 2011). Informed consent was obtained from all participants.

Results

The study was conducted with 389 pregnant women between 36-42 gestational weeks and with at least one prior cesarean delivery. The demographic variables of the cases were provided in Table 1.

Cases were divided into 3 groups according to adhesion severity. Grade 1 adhesion was found in 131 (33.7%) women and Grade 2 and grade 3 adhesion were found in 162 (41.6%) and 96 (24.7%) cases respectively. Statistical evaluation revealed no difference between the 3 groups in terms of demographic variables (p>0.05). The comparison of groups according to emergent or elective surgery also revealed no statistically significant difference (Table 2).

Table 1. Demographic variables of the cases

	Median (IQR)	Minimum	Maximum
Age (years)	27.00 (5)	18	41
Gravida (n)	3.00 (2)	2	8
Parity (n)	2.00 (1)	1	6
Gest age (w)	39.00 (2)	36	42
BW (g)	3285.00 (592)	2240	4620
BMI (kg/m²)	30.47 (5.67)	22.04	44.14
Previous CS (n)	2 (1)	1	4
Hb (g/dL)	12.20 (1.7)	8.2	16.3

IQR: Inter quartile range. BW: Birth weight. BMI: Body-mass index. Hb: Hemoglobin

Table 2. Effect of the emergent and elective cesarean section on the adhesion severity

			Adhesion Score						
			1		2		3		p
Emergent	n	%	83	34.9	82	34.3	74	30.8	0.188
Elective	n	%	50	33.0	66	44.4	34	22.6	

Table 3. Detailed comparison of the scar width and the adhesion scores

		Adhesion Score			
		1.	2.	3.	p
Scar width	Median	3.00	3.00	3.00	0.005 KW
	Minimum	1	1	1	0.054 *
	Maximum	5	5	5	0.001 **
	IQR	1	1	2	0.098 ***

* Comparison of Grade 1 and Grade 2 adhesion groups. ** Comparison of Grade 1 and Grade 3 adhesion groups. *** Comparison of Grade 2 and Grade 3 adhesion groups. P < 0.05: Statistically significant. KW: Kruskal-Wallis test IQR: Interquartile Range

The median scar length was 12(1) mm (min-max: 10-14 mm). Scar length was not associated with IPA severity (p=0.101). The median scar width was 3(1) mm (min-max:1-5 mm). Comparison of grade 1 and grade 3 adhesion groups revealed a statistically significant difference between them in terms of scar width (p=0.005) (Table 3).

Comparison of adhesion groups according to previous cesarean scar morphology (flat/non-flat) was not associated with the severity of IPA (p=0.097). On the other hand, scar pigmentation was significantly related to the IPA severity. Cases with darker or ligther colored scars had a higher rate of grade 3 adhesions than the cases with the scars of the same color relative to the neighboring skin (p=0.004). The relation between scar morphology, pigmentation and IPA severity is shown in Table 4.

Table 4. Effect of previous incision morphology and pigmentation on the adhesion scores

			Adhesion Score						
			1		2		3		
Scar morphology									p
Depressed	n	%	42	30.2	61	43.9	36	25.9	0.097
Flat	n	%	47	39.2	53	44.2	20	16.7	
Elevated	n	%	42	32.3	48	36.9	40	30.8	
Pigmentation									
Same	n	%	52	36.9	67	47.5	22	15.6	0.004
Lighter	n	%	41	39.4	32	30.8	31	29.8	
Darker	n	%	38	26.4	63	43.8	43	29.9	

Table 5. Comparison of abdominal sagging according to the adhesion subgroups

		Adhesion Score			
		1.	2.	3.	p
Abdominal sagging	Median	9.00	8.00	10.00	0.026 KW
	Minimum	3.00	3.00	3.00	0.993 *
	Maximum	14.00	16.00	17.00	0.011 **
	IQR	3.25	3.00	4.25	0.011 ***

* Comparison of Grade 1 and Grade 2 adhesion groups. ** Comparison of Grade 1 and Grade 3 adhesion groups. *** Comparison of Grade 2 and Grade 3 adhesion groups. P < 0.05: Statistically significant. KW: Kruskal-Wallis test IQR: Interquartile Range

When groups were compared for abdominal sagging, the grade 1 versus grade 3, and grade 2 versus grade 3 groups showed a statistically significant difference between them ($p<0.05$). There was no difference between the grade 1 and grade 2 groups ($p>0.05$). A detailed analysis of the comparison in terms of sagging is given in Table 5.

Correlation analysis demonstrated that scar width and BMI were positively correlated with adhesion severity ($p<0.05$) (Table 6).

Regression analysis showed that the most important parameter in the prediction of IPA severity was the degree of abdominal sag ($p=0.017$). As abdominal sag increased, the probability of the severity of IPA increased (Table 7).

Table 6. Results of correlation analysis between the adhesion scores and demographic variables.

		Gest. Age	Weight	Height	Age	Weight gain	Gravida	Parity
Adhesion Score	Rho	-0.102	-0.051	-0.094	-0.044	0.022	0.050	0.019
	p	0.045	0.320	0.086	0.389	0.662	0.328	0.707

		Scar length	Scar width	BMI	Hb	Abd. sagging
Adhesion Score	Rho	0.082	0.166	0.118	-0.020	0.135
	p	0.107	**0.001**	**0.028**	0.827	0.096

BMI: Body-mass index. Hb: Hemoglobin

Table 7. Ordinal regression analysis results of parameters that can affect intraperitoneal adhesion score

					95% Confidence Interval	
		Estimate	Std. Error	Sig.	Upper Bound	Lower Bound
Adhesion	1	-1.563	3.413	.647	-8.252	5.125
	2	1.215	3.415	.722	-5.479	7.909
Gravida		-.147	.216	.496	-.571	.277
Parity		.149	.301	.620	-.440	.738
Scar length		-.086	.215	.688	-.508	.335
Scar width		0.310	0.261	0.236	-0.202	0.822
Abdominal Sagging		0.172	0.072	**0.017**	0.031	0.313
BMI		-0.038	0.040	0.352	-0.117	0.042
Age		-0.041	0.051	0.424	-0.142	0.060
Prev CS	Elective	0.403	0.440	0.360	-0.460	1.265
	Emergent	0.0	0.0	0.0	0.0	0.0
Incision	Depressed	-0.067	0.464	0.885	-0.977	0.842
	Flat	-0.067	0.458	0.884	-0.964	0.831
	Elevated	0.0	0.0	0.0	0.0	0.0
Pigmentation	Same	0.606	0.485	0.211	-0.344	1.556
	Lighter	0.599	0.558	0.284	-0.496	1.693
	Darker	0.0	0.0	0.0	0.0	0.0

Discussion

Wound healing is a normal biological process in the human body. For a wound to heal successfully, all phases of healing must occur in the proper sequence and time[13]. The perfect wound healing occurs with minimal or no scarring. Wound healing that results in tissue nearly as normal would result in a scar close to the original tissue. Healing into a normal pigmented flat scar, means near perfect healing with minimal scarring. The same principle is also true for healing in the abdominal cavity. Successful healing would result in less reaction with minimal or no fibrosis and/or adhesion formation. Since the healing process is generally similar in all parts of the body for an individual, the hypothesis of this study was that healing of a skin incision might give some idea about healing success in the abdominal cavity.

There are a limited number of studies in the literature about this subject. In the study of Doğan et al, they found that scar length, width and type (flat or non-flat) were directly related to adhesion formation. Scars with flat contours were not accompanied by dense IPA in 93.2% of cases. Elevated scars had significantly more dense adhesion formation than depressed ones. Regarding pigmentation, pigmented scars had more dense adhesions than non-pigmented ones[14]. In another study, authors divided abdominal scars into flat and non-flat (elevated and depressed scars) preoperatively. They found an association between depressed scars and dense adhesions[15]. Similarly Kahyaoğlu et al found a relation between depressed abdominal scars and IPAs, whereas the pigmentation status of the scar (hyperpigmented and non-pigmented) did not differ between women with or without adhesions[16].

Taylan et al conducted a similar study but they chose the study group from women who had undergone at least one previous abdominal surgery including laparoscopy, laparotomy or CS. They found a significant difference between the adhesion and no adhesion groups in terms of previous scar characteristics (color, appearance, contour, distortion). However, correlation analysis did not reveal a significant relation between adhesion and skin scar parameters[17].

In our study we found that as previous incisional scar appearance gets closer to the individual's original skin (meaning that normal-pigmented, flat, and thin scars), the severity of IPA decreases. An important point of our study was the determination of lower abdominal sagging by our own method. In previous studies with a similar subject, other items such as prior scar length, width, pigmentation, etc. have been evaluated. All of these parameters are related to skin-scar characteristics of the individuals. However abdominal sag is a parameter that is related to the healing process below the skin, at the level of subcutaneous tissue and fascia. It is caused by scar formation and contraction below the incisional site at the fascia level causing inward traction of the skin by the fibrovascular bands of the adhesions. Our hypothesis is that the healing process at the fascia level might reflect the healing process and adhesion formation in the abdominal cavity. Our results showed that a sagging abdomen is highly associated with adhesion and it could be a good marker for preoperative adhesion prediction.

The strengths of our study include the fact that the results of the study could be reflected in clinical practice. Preoperative evaluation of the scar and sag can help surgeons to prepare and to counsel patients for a potentially complicated surgery. For suitable cases, it may provide insight about the benefit of a future trial of labor versus a planned repeat cesarean.

There are some limitations to our study. Firstly, the number of cases, although adequate, is

not high enough to generalize the results. Secondly, biopsies could have been taken from the scar tissue at the incisional site and from the IPAs to investigate molecular mechanisms causing different types and degrees of adhesions. Thirdly, most of the patients in our study were operated by different surgeons in their previous CS. So our patient group was not a homogeneous group in terms of surgeon, surgical methods, suture materials and post-operative care in terms of their previous operation. In fact, the personal history of patients about previous surgery (fever, blood loss, duration, preoperative diagnosis, indication, and operator experience) may increase the pre-operative prediction possibility of IPAs. However, we did not use these factors due to insufficient data. Another important point is the effect of pregnancy on adhesion development. Although IPAs develop in the majority of intra-abdominal and pelvic surgeries there might be some differences between gynecological and obstetrical surgery (between pregnant and non-pregnant women) in terms of adhesion development. The other important issue is the use of sonographic measurement of visceral slide (longitudinal movement of the viscera during a cycle of respiration) for the detection of adhesions. Previous scar characteristics could be compared with preoperative ultrasonography to test both of them for predictive accuracy. In this way both methods can be combined to increase IPA prediction power. Lastly, skin healing and uterine or peritoneal healing may be different from each other. There is no known documented biologic mechanism explaining parallel healing of different tissues. All of these limitations are the subject of new studies about this topic.

In conclusion, the severity of IPA was significantly related to scar width and the degree of abdominal sagging. Evaluation of skin / scar characteristics together with abdominal sag before laparotomy could help the surgeon to be prepared for IPA related complications.

Conflicts of Interest

There is no conflict of interest reported by the authors.

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