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Original Article

Are the cesarean section skin scar characteristics associated with intraabdominal adhesions located at surgical and non-surgical sites

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ABSTRACT

Objective: To investigate whether skin scar characteristics are associated with the presence and severity of abdominal or pelvic adhesions in women who have undergone previous cesarean section.
Methods: In this prospective study, 104 women who had undergone at least one previous cesarean section and were scheduled for laparoscopic surgery due to benign gynaecologic indications were included. Preoperative skin scar characteristics as well as intraoperative adhesions were evaluated using the modified Manchester Scar Scale and the Peritoneal Adhesion Index, respectively.
Results: During laparoscopic surgery, adhesions were detected in the upper region of the abdominal cavity in 30 women, in the middle region in 46 women and in the lower region in 82 women. Total abdominal scar scores were significantly increased in women with adhesions in all three adbominal regions. Multiple cesarean section scars and palpable scars were more common in women with adhesions. Significant positive correlations were found between the skin scar and adhesion scores in all abdominal regions.
Conclusion: The skin scar characteristics of the previous caesarean section are associated with the presence and severity of pelvic and abdominal adhesions. Skin scarring especially with palpable texture may be an indicator of adhesion formation in the entire abdominopelvic cavity.

Introduction

Adhesions are potential risks of abdominal or pelvic surgery that can lead to several perioperative and postoperative complications including intestinal obstruction, chronic abdominal and pelvic pain, ectopic gestation and female infertility and cause hospital readmision and repeat surgery due to these complications. Adhesions also increase surgical risks such as bladder or bowel injury for subsequent operations, extend the duration of the surgery and create a significant burden to health care system [1,2]. Therefore, preventing adhesion formation and predicting them before surgery is important to reduce the related morbidities. However, there is still no effective and reliable method for preventing or predicting adhesions, completely [2].

Skin scar and intra-abdominal adhesion formations are both wound-healing processes and there are biologic similarities between these healing processes [3,4]. Beside these similarities, skin scaring is not similar for everyone and may vary from person to person [5]. Based on these similarities and variations, different skin scar characteristics may reflect the state of intra-abdominal adhesions. In literature there are few and conflicting data regarding the relationship between the skin scar characteristics and intra-abdominal or pelvic adhesion formation [6–9].

In this study we aimed to investigate whether skin scar characteristics are associated with the presence, severity and extent of intra-abdominal or pelvic adhesions in women who have undergone previous cesarean section (CS).

Material and methods

This prospective cohort study was conducted at the gynaecology department of a tertiary referral education hospital in Ankara, Turkey during the period from January 2016 to January 2017. Women who had undergone at least one previous CS and were scheduled for laparoscopic surgery due to benign gynaecologic indications such as tubal ligation, ectopic pregnancy and uterine

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fibroids were included. Women who had previous pelvic infection, postoperative wound complications such as infection and hematoma, endometriosis and any systemic inflammatory disease such as, inflammatory bowel disease, diabetes, systemic lupus erythematosus and vasculitis were excuded. All women were informed about the study and informed consent was obtained from each woman. The study was approved by the local ethics committee of the hospital.

Demographic caharacteristics of women including age, body mass index (BMI), previous surgery history were recorded. Hospital records showed that skin incisions of previous CS were closed with nonresorptive subcutaneous continuous sutures. All participants were Caucasian, therefore ethnicity was not included as a study parameters.

Preoperatively, each of previous operation scar assessment was performed according to the modified Manchester Scar Scale (MSS) [5,10] by a member of the study team who did not attend to the operation in order to avoid bias. The modified MSS evaluates and scores seven scar parameter including scar color, (perfect, slight, obvious, or gross discrepancy compared with surrounding abdominal skin), surface appearance (matte or shiny), contour (flush or not flush with surrounding skin), texture (normal or palpable), margins (distinct or indistinct), size (<1 cm, 1–5 cm, or >5 cm), and number (single or multiple scar sites). Scores for each parameter begin with 1 and increases as 2,3 and 4 according to the queue of parameter item. The low total score of these parameters shows minimal scarring, while a high total score shows marked and abnormal scarring. In women with multiple skin scars, the numerical value of each scar characteristic providing the highest scar score was used in the statistical analysis, and the mean scar score was calculated.

The surgeon who did not know the skin scar score graded intraabdominal adhesions following the abdominal entry in laparoscopic surgery according to Peritoneal Adhesion Index (PAI) [11]. PAI classified adhesions based on their macroscopic appearance and their diffusion to different regions of the abdominal cavity. In PAI the abdominal cavity is divided into 9 regions (right upper, epigastrium, left upper, right flank, central, left flank, right lower, pelvis, left lower) and the numerical scores of adhesions in each region are graded according to severity (0 = no adhesion; 1 = filmy/avascular, fit to blunt dissection; 2 = strong/some vascularity, fit to sharp dissection; 3 = very strong/vascular, fit tos harp dissection but damage is hardly preventable). The sum of adhesion grades of regions produce final score. In our study we combined these 9 regions into 3 regions: the upper region (consisting of right upper, epigastrium, left upper regions), the middle region (consisting of right flank, central, left flank regions) and the lower region (consisting of right lower, pelvis, left lower regions). The upper and middle regions were considered as non-surgical cite adhesion regions.

Statistical analyses were performed using the Statistical Package for the Social Sciences for Windows 17.0 software (SPSS, Chicago, IL., USA). Variables were given as number (percentage) for categorical variables and mean ± standard deviation or median (minimum-maximum value) for continuous variables. Between two groups, parametric comparisons were performed using Student's *t*-test, and non-parametric comparisons were performed using Mann–Whitney U test. $\chi 2$ or Fisher's exact tests were performed to compare categorical variables as appropriate. Kruskal Wallis test was used for multiple group comparisons. Correlations between scar and adhesion scores were analyzed using the Spearman's correlation coefficient. p values of <0.05 were considered statistically significant.

Results

Following the exclucions, 104 women were included in the study. During laparoscopic surgery, adhesions were detected in the upper region of the abdominal cavity in 30 women, in the middle region in 46 women and in the lower region in 82 women. Preoperative patient characteristics including woman's age, BMI, number of previous CS, years since the last CS and skin scar length were listed in Table 1. No statistically significant difference was found between the patients with and without adhesion for each of region of the abdominal cavity in terms of patient characteristics.

In Table 2, assessments of the abdominal skin scar characteristics using modified MSS were listed. In upper, middle and lower abdominal region, total abdominal scar scores were significantly increased in women with adhesions than in without adhesions. Similarly, multiple CS scars and palpable scars were more common in women with adhesions compared to women without adhesions. The other skin parameters did not reveal a statistical difference in all three adbominal regions The total PAI score and adhesion severity were significantly increased from the upper abdominal region to the lower abdominal region (Table 3). The upper bladder surface (%79.3) and anterior uterine surface (%73.2) in the lower abdominal region were the most common locations for adhesions.

Significant positive correlations were found between the MSS and PAI scores in all three abdominal regions, and these positive correlations was noted to increase from the upper abdominal region to the lower region. (Table 4).

Discussion

In this current study, we investigated whether the evaluation of previous CS scar characteristics could inform us about the presence and severity of adhesions prior to subsequent surgery and we found some significant results. Firstly, we noted that skin scar scores were higher in the presence of adhesion for each of the lower, middle and upper abdominal

Table 1
Characteristics of women.

	Upper Region		p	Middle Region		p	Lower Region		p
	No adhesion (n = 74)	Adhesion (n = 30)		No adhesion (n = 58)	Adhesion (n = 46)		No adhesion (n = 22)	Adhesion (n = 82)	
Age (years)	30.11 ± 3.26	28.33 ± 3.98	0.102	29.38 ± 3.20	29.87 ± 3.99	0.625	29.82 ± 3.03	29.54 ± 3.69	0.817
BMI (kg/m^2)	28.50 ± 0.44	28.46 ± 0.56	0.812	28.53 ± 4.57	28.43 ± 4.97	0.483	28.38 ± 0.48	28.52 ± 0.47	0.391
No. of previous cesarean	1.49 ± 0.72	1.60 ± 0.60	0.601	1.41 ± 0.63	1.65 ± 0.78	0.226	1.09 ± 0.3	1.63 ± 0.73	0.021
Years since last cesarean (years)	4.05 ± 1.63	3.73 ± 1.39	0.507	4.00 ± 1.51	3.91 ± 1.64	0.844	3.55 ± 1.29	4.07 ± 1.62	0.324
Scar Length (cm)	13.49 ± 1.80	13.20 ± 1.90	0.612	13.72 ± 1.79	13.0 ± 1.81	0.156	13.91 ± 2.07	13.27 ± 1.75	0.304

Variables were presented as mean ± standard deviation.
BMI: Body mass index.
p < 0.05 was considered statistically significant.

Table 2
Skin scar characteristics of women.

	Upper Region		p	Middle Region		p	Lower Region		p
	No adhesion (n = 74)	Adhesion (n = 30)		No adhesion (n = 58)	Adhesion (n = 46)		No adhesion (n = 22)	Adhesion (n = 82)	
Color			0.551			0.151			0.109
Perfect	26 (35.1)	8 (26.7)		22 (37.9)	15 (32.6)		13 (59.1)	26 (31.7)	
Slight mismatch	28 (37.8)	10 (33.3)		20 (34.5)	15 (32.6)		5 (22.7)	28 (34.1)	
Obvious mismatch	18 (24.3)	10 (33.3)		12 (20.7)	16 (34.8)		3 (13.6)	25 (30.5)	
Gross mismatch	2 (2.7)	2 (6.7)		4 (6.9)	0 (0.0)		1 (4.5)	3 (3.7)	
Apperance			0.406			0.567			0.071
Matte	46 (62.2)	16 (53.3)		36 (62.1)	26 (56.5)		16 (72.7)	42 (51.2)	
Shiny	28 (37.8)	14 (46.7)		22 (37.9)	20 (43.5)		6 (27.3)	40 (48.8)	
Contour			0.718			0.430			0.678
Flush with surrounding skin	52 (70.3)	20 (66.7)		42 (72.4)	30 (65.2)		15 (68.2)	52 (63.4)	
Not flush with surrounding skin	22 (29.7)	10 (33.3)		16 (27.6)	16 (34.8)		7 (31.2)	30 (36.6)	
Texture			0.003			0.004			<0.001
Normal	26 (35.1)	2 (6.7)		22 (37.9)	6 (13.0)		17 (77.3)	10 (12.2)	
Palpable	48 (64.9)	28 (92.3)		36 (62.1)	40 (87.0)		5 (22.7)	72 (87.8)	
Margins			0.312			0.213			0.309
Distinct	52 (70.3)	18 (60.0)		42 (72.4)	28 (60.9)		16 (72.7)	50 (61.0)	
Indistinct	22 (29.7)	12 (40.0)		16 (27.6)	18 (39.1)		6 (27.3)	32 (39.0)	
No. of incicions			0.039			0.025			<0.001
Single	46 (62.2)	12 (40.0)		38 (65.5)	20 (43.5)		20 (90.9)	38 (46.3)	
Multiple	28 (37.8)	18 (60.0)		20 (34.5)	26 (56.5)		2 (9.1)	44 (53.7)	
Total Manchester Scar Score	8 (6–14)	9 (6–14)	0.031	8 (6–14)	9 (6–14)	0.031	6 (6–13)	9 (6–14)	<0.001

Variables were presented as median (min-max) and number (%).
$p < 0.05$ was considered statistically significant.

Table 3
Peritoneal Adhesion Index score and grade of women.

	Upper Region	Middle Region	Lower Region	p
Total PAI Score	0 (0–6)	0 (0–7)	6 (0–9)	<0.001
PAI Grade				
Grade 0	74 (71.2)	58 (55.8)	22 (21.2)	
Grade 1	16 (15.4)	30 (28.8)	12 (11.5)	
Grade 2	14 (13.5)	12 (11.5)	36 (34.6)	
Grade 3	0 (0.0)	4 (3.8)	34 (32.7)	

Variables were presented as median (min–max) and number (%).
PAI: Peritoneal Adhesion Index.
$p < 0.05$ was considered statistically significant.

Table 4
The association between modified MSS score and PAI scores of each abdominal region.

	r	p
MSS&Upper Region PAI score	0.219	0.026
MSS&Middle Region PAI score	0.287	0.003
MSS&Lower Region PAI score	0.593	<0.001

r: Spearman's correlation coefficient.
MSS: Manchester Scar Scale; PAI: Peritoneal Adhesion Index.
$p < 0.05$ was considered statistically significant.

regions, and there were positive correlations between the scar and adhesion scores in all three regions. These results indicated that the evaluation of the skin scar could provide information about the presence and severity of adhesions in the abdominal cavity. Wound healing is a process affected by immunological, genetic and hormonal factors along with tractional forces that lead to the regeneration of tissues on internal or external body surfaces. Both the cutaneous and serosal wound healing has comparable exudation, resorption and regeneration phases. Also some mediators involved in these healing processes are similar [12]. Because of these similarities in the wound healing process of dermis and peritoneum, it is theoretically probable that abdominal scar features may be beneficial in the prediction of intraabdominal adhesions. When the literature is examined, it is seen that some studies support this theory, even if the results are conflicting. Namely, Salim et al. and Kahyaoglu et al. reported that depressed CS skin scars are more likely to have intra-abdominal adhesions than flat and elevated scars [6,8]. In contrast, Doğan et al. and Stocker et al. respectively noted that the incidence of abdominal and pelvic adhesion was higher in women with hypertrophic and palpable skin scars [7,9]. In our study, the women who had palpable scar textures were also more likely to have adhesions in each abdominal region compared with those who had nonpalpable scar. The collagen fibers are organized during wound healing. The abdominal scars with palpable texture have more collagen fibers than those of normal texture [13]. This increase in collagen fibers is especially due to aberrant and overproduction of transforming growth factor beta (TGF-β) [13,14]. Increased TGF- β level plays a pivotal role in in vivo wound healing, and simultaneous fibrosis causing intraabdominal adhesions [15–17]. In animal models, it has been shown that intraperitoneal application of TGF-b to surgical area or adhesions resulted in formation or worsening of the adhesions [3]. Additionally, it has been shown scars might be transformed to pigmented, hypertrophic scars by experimentally overexpression of TGF-β in genetically susceptible animals [18]. Therefore, the more frequent adhesion in women with palpable scars may be caused by an aberrant or increased cytokine release in the inflammatory process during healing. Unfortunately, we could not evaluate this issue in our study. But, we think that this issue is an important topic that can be evaluated in future studies.

In our study, although we detected the most adhesion in the pelvic region after CS, we also found that adhesions may be present in non-surgical site regions away from the pelvic cavity. In addition, the presence and severity of these adhesions were interestingly associated with the skin scar characteristics, as well. When the literature is reviewed, we found that there were two similar studies evaluating skin scarring and adhesions in the entire abdominopelvic cavity. In

one, Stocker et al. examined the relationship between the skin scar characteristics of previous abdominopelvic operations and abdominal adhesions detected during elective current gynecologic laparoscopic surgery and found that women with more than one abdominal scar, a palpable scar, and/or a longer scar were most likely to have pelvic adhesions during the current surgery and women with the highest mean scar scores also had a greater total adhesion score [9]. However, in this study, it is not clear in which abdominal field the surgery was performed and therefore the role of abdominal scar characteristics in predicting adhesions away from the surgical site is insufficient. In another study, Taylan et al. evaluated the skin scars of women who had undergone previous abdominal surgery before caesarean section and found that women who had adhesion in the abdominal cavity during CS had higher skin scar scores [19]. However evaluation of abdominal adhesions during CS is not a fully effective method. Theoretically, assessment of adhesions via laparoscopy is a better and more reliable method for determining the presence, severity and localization of adhesions than laparotomy or caesarean section. Considering such limitations of these two studies, we believe that our results are more effective and reliable. After a surgical incision, peritoneal healing occurs across the entire surface, while skin healing occurs only between the edges of the wound [20,21]. Therefore, adhesions may occur in the entire abdominopelvic cavity following an abdominopelvic surgery and similar cellular and molecular mechanisms may be the cause of relationship between skin and peritoneal scarring.

In our study, the women who had multiple CS scars were more likely to have adhesions in each abdominal region compared with those who had a single. CS is one of the most commonly performed surgical operations worldwide and the number of repeated CS is increasing day by day. Previous studies have shown that CS related to a high risk of adhesion formation, especially localized in pelvis. Each subsequent CS increases the incidence and severity of women with adhesions. Namely, adhesion incidence was reported as 46% and 75% respectively after the first and a third CS [22,23]. It may be assumed that recurrent surgeries are associated with the recurrent and new healing process and therefore more adhesion formation is expected.

Our study is not without limitations. The lack of information about previous operations was the main limitation. Therefore, factors that colud be effective in healing and adhesion formation process such as surgical technique, closing or not closing the visceral/parietal peritoneum, the type of suture material used, using or not using of antiadhesive agents and the presence of any intraoperative complications were not available in this study. In addition, although women with a history of pelvic inflammatory disease and endometriosis were excluded from the study, these conditions may have led to abdominopelvic adhesions in silent and/or undiagnosed women.

In conclusion, we have found that the skin scar characteristics of the previous caesarean section are associated with the presence and severity of pelvic and intraabdominal adhesions. Skin scarring especially with palpable texture may be an indicator of adhesion formation in the entire abdominopelvic cavity This may be useful for the surgeons or clinicians in order to estimate the presence of adhesions during clinical evaluation or before surgery. In particular, prior to laparoscopic surgery, the evaluation of skin scars of previous operations may provide important information in the selection of less risky sites during the primary port placement and consequently may prevent possible visceral organ injuries related to intraabdominal adhesions during abdominal cavity access. However, we believe that there is a need for prospective randomized controlled studies with broad participation to demonstrate the accuracy of this practical approach and to increase its application.

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Competing interest statement

The authors declare no conflict of interest.

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