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Do Skin Color and Striae Severity in Term Pregnancy Predict Intraperitoneal Adhesions in Women with Previous Cesarean Section?

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ABSTRACT

Objectives: The study aimed to assess the natural skin color and striae (stretch marks) characteristics in pregnant women and to explore their association with the presence and severity of intraperitoneal adhesions (IPA) during repeat cesarean deliveries.

Materials and Methods: Three hundred eighty-nine pregnant women were included in the study. Before the operation, patients' natural skin color, and the presence and localization of striae were recorded. During the cesarean section, adhesions were scored according to the clinical adhesion scoring system.

Results: There was no significant relation between natural skin color and adhesion severity. Striae characteristics were not related to adhesion severity. However, the severity of striae above the umbilicus is an important marker for the prediction of IPA.

Conclusions: This study indicates that while natural skin color and overall striae characteristics do not predict adhesion severity, severe striae located above the umbilicus can be an effective preoperative indicator for intraperitoneal adhesions in repeat cesarean patients.

KEYWORDS
Cesarean, adhesion, striae, skin color.

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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] Similar to other intra-abdominal operations, CS is associated with intraperitoneal adhesion (IPA) formation. These adhesions may cause significant morbidity and, to a lesser extent, mortality, difficulty in entering the abdominal cavity during surgery, longer time to deliver the baby, increased risk of bowel/bladder/organ injury, bleeding, increased operative time and hospital stay during repeat cesarean.[3-7] Therefore, the prediction of IPA before performing laparotomy is important for the preparation of the surgical team for possible surgical risks and the 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, tissue, and scar characteristics of an individual person in addition to surgical techniques influence the healing process and speed.[8,9] For skin wounds, there is a relation between skin color and pathological scar formation. It's well known that the incidence of keloid formation is higher in Black people than in White people. Additionally, patients who suffer from albinism rarely develop keloids.[9]

This observation suggests that the formation of intraperitoneal adhesions (IPA), linked to abnormal peritoneal healing, might also be influenced by natural skin color, similar to the relationship between skin color and pathological scar formation. However, existing studies on this topic are limited and offer inconclusive results.

Striae Gravidarum (SG) is seen very frequently in pregnant women.[10,11] Although the exact cause remains unknown, mechanical stretching of the skin, hormonal changes due to pregnancy, and the connective tissue structure of women are blamed in the pathogenesis of SG.[11-13] Striae formation and severity reflect personal skin and tissue characteristics. During pregnancy, a good tissue quality can be predicted by observing less or no striae formation, which might indicate better wound healing and less intra-abdominal adhesion formation. In this study, the skin color and striae characteristics of women with previous CS were evaluated to find if these parameters have any value in the prediction of IPAs at repeat cesarean delivery.

Material and Methods

This study was conducted by retrospective examination of a prospective cross-sectional study that was conducted between December 2011 and June 2015 in Nene Hatun Gynecology and Obstetrics Hospital, Erzurum, Turkey. Three hundred eighty-nine pregnant women who met the 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 postpartum care in the same hospital. Pregnant women with any 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 were excluded from the study. Approval for this study was obtained from the Local Institutional Review Board of the Faculty of Medicine, Turgut Özal University. Informed consent was obtained from all participants.

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 deliveries, and preoperative hemoglobin levels were recorded. Patients' natural skin color scoring was performed using the Fitzpatrick skin color scale before the operation and recorded.[14] There are very few/no Black people in Turkiye so they

were not included in the study. The presence of SG was evaluated at the same time. Severity scoring of SG was done by using the numerical scoring system of Atwal et al.[10] According to this system, abdominal striae were graded as Grade 0 if no striae were present, Grade 1 if less than 5 striae were present, grade 2 if 5-10 striae were present, and grade 3 if more than 10 striae were present. Striae below and above the umbilicus were counted and recorded separately.

All patients underwent 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. Then, an evaluation of IPA was done. Adhesions were scored according to the clinical adhesion scoring system of Linsky et al.[15] The adhesion area was classified into three grades, as follows: grade 1, none or filmy, avascular, ≤25% of the area; grade 2, dense or vascular, 25-50% of the area; and grade 3, dense and vascular, 50-100% of the area. After scoring IPA and 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. The neonatal weight was recorded.

Power analysis of the study showed that a total of 343 patients were 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, IL, 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 the 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.

Results

The study was conducted with 389 pregnant women between 36-42 gestational weeks 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, hemoglobin levels, and CS indications (p>0.05).

The natural skin colors of the women according to the Fitzpatrick skin color scale were assigned as 119 (30.6%) Type I-II, 145 (37.3%) Type III, and 125 (32.1%) Type IV. Since number of the Fitzpatrick skin color scale Type 1 cases very small, they were combined with Type 2 cases. Comparison of the adhesion groups in terms of the skin color did not reveal any important relationship between them (p=0.314) (Table 2).

All pregnant women in this study had striae below the umbilicus. Striae in the upper abdomen were present in most of the cases (88%). However, 47 (12%) cases had no striae above the umbilicus.

The assessment of the relation between SG and IPA showed no relation between adhesion severity and SG grade. Although patients with grade 3 striae had a higher grade 3 adhesion rate, the difference did not reach statistical significance (p=0.275 and p=0.179, respectively) (Table 3).

Correlation analysis demonstrated that BMI was the only parameter that was positively correlated with adhesion severity (p<0.05) (Table 4).

According to regression analysis, the most important parameter in the prediction of IPA was the grade of striae above the umbilicus (p=0.018). The probability of adhesion increased with increased striae grade above the umbilicus (Table 5).

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/m^2)	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. Relation between the natural skin color and the adhesion scores.

		Adhesion Score			
Natural skin color		**1**	**2**	**3**	p
Type I-II	n (%)	37 (31.1)	56 (47.1)	26 (21.8)	0.314
Type III	n (%)	56 (38.6)	56 (38.6)	33 (22.8)	
Type IV	n (%)	38 (30.4)	50 (40.0)	37 (29.6)	

p< 0.05 is significant

Table 3. Effect of striae score (below and above the umbilicus) on the adhesion severity.

Stria Below Umbilicus		**Adhesion Score**			
		1	2	3	p
1	n (%)	28 (45.9)	20 (32.8)	13 (21.3)	0.275
2	n (%)	69 (31.1)	98 (44.1)	55 (24.8)	
3	n (%)	34 (32.1)	44 (41.5)	28 (26.4)	
Stria Above Umbilicus					
0	n (%)	21 (44.7)	19 (40.4)	7 (14.9)	0.179
1	n (%)	53 (30.5)	75 (43.1)	46 (26.4)	
2	n (%)	48 (33.6)	62 (43.4)	33 (23.1)	
3	n (%)	9 (36.0)	6 (24.0)	10 (40.0)	

Table 4. Results of correlation analysis between the adhesion scores and demographic variables.

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

		Weight gain in preg.	**Hb**	**Stria above umbilicus**	**Stria below umbilicus**	**BMI**
Adhesion Score	Rho	0.022	-0.020	0.048	0.067	0.118
	p	0.662	0.827	0.342	0.190	**0.028**

BMI: Body-mass index. Hb: Hemoglobin

Table 5. Ordinal regression analysis results of the parameters that can affect IPA 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
BMI		-0.038	0.040	0.352	-0.117	0.042
Age		-0.041	0.051	0.424	-0.142	0.060
Stria above U	0	-2.194	0.942	0.020	-4.040	-0.349
	1	-0.725	0.812	0.372	-2.316	0.866
	2	-0.388	0.780	0.619	-1.918	1.142
	3	0.0	0.0	0.0	0.0	0.0
Stria below U	1	0.451	0.637	0.480	-0.799	1.700
	2	-0.013	0.431	0.976	-0.859	0.832
	3	0.0	0.0	0.0	0.0	0.0
Prev CS	Elective	0.403	0.440	0.360	-0.460	1.265
	Emergent	0.0	0.0	0.0	0.0	0.0
Skin color	I-II	0.020	0.443	0.964	-0.848	0.887
	III	0.0	0.0	0.0	0.0	0.0
	IV	-0.299	0.466	0.521	-1.212	0.615

$p<0.05$ Statistically significant.

Discussion

There is a relation between skin color and pathological scar formation. Individual skin pigmentation is important for wound healing and scar formation. The best examples for this are the higher incidence of keloid formation in Black people and the rare development of keloid in albino cases.[9] Similarly, there may be an association between skin color and intra-abdominal adhesion formation, just like the association between individual skin color and keloid formation. In addition to this, pregnant women are more susceptible to developing keloids due to increased hormone secretion and higher skin pigmentation.[16] Therefore, women with previous CS might have an association between skin color and IPA.

In the research conducted by Altınboğa et al., a notable correlation was observed between increased skin color darkness and a rise in adhesion density. The findings led to the conclusion that higher Fitzpatrick scores were associated with elevated abdominal adhesion scores and a greater incidence of depressed skin scars.

In the present study we found no association between different skin color tones and IPA

formation. An explanation for this may be found by considering the difference between the healing processes of the peritoneal cavity and skin. Although the etiopathogenesis of IPA is not clearly known, it is thought to be caused by peritoneal injury, ischemia, inflammation, and the subsequent production of a fibrin matrix. At the beginning, the fibrin matrix is used for approximation of injured peritoneal surfaces to each other, then fibrin bands are removed fibrinolytically and healthy tissue develops. So normal peritoneal healing and adhesion formation are related to the balance between fibrin deposition and degradation. Any condition that disrupts fibrinolytic activity and prevents complete fibrin degradation results in adhesion formation.[17,18] However, skin healing is different from peritoneal healing in terms of the presence of melanocytes. Melanocytes are located in the basal layer of the squamous epithelium and are responsible for skin pigmentation. When any trauma to the skin occurs, inflammatory cytokines are released, causing proliferation of melanocytes, fibroblasts, migration to the injured area, granulation formation, and increased melanin formation.[19] During this process, when fibroblasts come into contact with a higher number of melanocytes, it may cause hypertrophic scar, keloid formation, and hyperpigmentation. Since melanocytes are absent in the peritoneal lining, a similar association was not found between skin color and IPA.

Striae formation is mostly related to the individual skin characteristics. It is very frequent during pregnancy such that up to 90% of pregnant women develop SG.[20] Many factors are blamed for the development of SG such as mechanical stretching, poor skin elasticity, hormonal changes, and decreased tissue elastin-collagen levels.[21] Among these factors, one of them is related to both striae formation and peritoneal adhesion. This important factor is fibroblast activity and collagen levels. Fibroblasts, which are the major collagen producing cells, play an important role in both peritoneal adhesions, and striae formation by regulating collagen synthesis.[22] Collagen levels are decreased in SG. This is possibly related to the defective fibroblasts and defective collagen synthesis. On the other hand, IPA is caused by incomplete degradation of fibrin, which causes fibroblasts to produce collagen, and ineffective collagen degradation in turn causes ineffective peritoneal healing and IPA formation. Thus, the development of SG and IPA formation may share a common pathway related to defective fibroblasts and collagen synthesis. All this information leads us to think that SG presence and severity might reflect an individual's peritoneal healing condition and consequently adhesion formation.

Regarding this subject, Gungor et al. examined the relation between striae formation and adhesion. They found that the striae status of a patient might predict IPA status before planning a new operation with a sensitivity and specificity of 95.2% and 29.4%, respectively. They found that having severe SG was sensitive (80.95%) but less specific (50%) in the prediction of IPAs.[23]

A similar study done by Doğan et al.[24] showed an association between the presence of striae and IPA formation. According to their results, the adhesion score decreased significantly as the striae score increased. Their sensitivity and specificity levels for IPA were 55% and 67%, respectively, with a positive predictive value of 69% and a negative predictive value of 52%. However, in another study done by Çelik et al., the authors did not find any association between striae and IPA severity.[25]

In the present study, we did not find any significant relation between striae and IPA formation. However, the probability of IPA formation and severity increased with increased SG presence above the umbilicus. The most

important parameter that was highly correlated with adhesion severity was the BMI of the patient. Both high BMI and the severity of SG above the umbilicus could be used as markers for the preoperative prediction of IPA.

The strength of our study includes that the results of this study could be reflected in clinical practice. Evaluation of striae and BMI is very easy, cheap, and non-invasive. They can help surgeons prepare for a possible complicated surgery.

There are some limitations to the study. Firstly, the number of cases, although adequate, is not high enough to generalize the results. Additionally, our patient groups consisted of White people since there are no Black women in our country. Secondly, biopsy could have been taken from the skin, striae, and 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 on by different surgeons in their previous CS. Thus, our patient group was not a homogeneous group in terms of surgeon, surgical methods, suture materials, and post-operative care. In fact, patients' personal history about previous surgery (fever, blood loss, duration, preop diagnosis, operator experience) may increase the pre-operative prediction possibility of IPAs. However, we could 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. This subject remains to be solved. 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. Both methods could be combined to increase the prediction power of IPA. Lastly, skin, uterine, or peritoneal healing may be different and there is no known documented biologic mechanism explaining parallel healing of these different tissues. All of these points are the subject of new studies about this topic.

In conclusion, the severity of IPA was not related to skin color and SG, but striae characteristics may help in the prediction of IPA. However, new studies with a large number of cases are needed to support this and to exactly guide surgeons in preparing for possible complications.

Ethics Approval

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).

Conflicts of Interest

There is no conflict of interest reported by the authors.

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