The effectiveness of preoperative diagnostic methods in predicting intra-abdominal adhesions before repeat cesarean section delivery

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SUMMARY

OBJECTIVE: This study aimed to evaluate the effectiveness of skin appearance, striae gravidarum severity, and ultrasonographic "sliding sign" in predicting preoperative adhesions before repeat cesarean section delivery on the same patient and find the most useful one.
METHODS: This was a prospective cohort study conducted on pregnant women with a history of cesarean section delivery. Davey's scoring system was used for stria evaluation. The scar was assessed using their visual appearance, and transabdominal ultrasonography was applied to detect sliding sign existence. Surgeons blinded to preoperative assessment graded the severity of intra-abdominal adhesions intraoperatively using Nair's scoring system.
RESULTS: Of the 164 pregnant women with at least one previous cesarean section delivery, 73 (44.5%) had filmy or dense intra-abdominal adhesions. Statistically significant association was found between three groups regarding parity, previous cesarean number, scar appearance, total stria score, and sliding sign existence. Negative sliding sign had a likelihood ratio of 4.198 (95%CI 1.178–14.964) for the detection of intra-abdominal adhesions. Stria score and scar appearance were also valuable for detection adhesions with likelihood ratios of 1.518 (95%CI 1.045–2.205) and 2.405 (95%CI 0.851–6.796), respectively. After receiver operator characteristics curve analysis, striae score cutoff value in adhesion prediction was determined as 3.5.
CONCLUSION: Stria score, scar appearance, and sliding sign are all significant predictors for intraperitoneal adhesions, and sliding sign, as an easy-to-apply, inexpensive, useful sonographic marker, is the most effective adhesion predictor before repeat cesarean section delivery compared to other known adhesion markers.
KEYWORDS: Surgery. Cesarean section. Ultrasonography.

INTRODUCTION

Cesarean section (CS) delivery is currently one of the most common obstetric operation, and its rate increased steadily from 5 to 30–32% over the past 10 years[1]. Intra-abdominal adhesions can occur in 46–83% of women who undergo repeat CS, leading to bleeding, bladder and bowel injury, infection, hysterectomy, and neonatal morbidity in subsequent surgeries[2,3].

Aiming this, various noninvasive methods including skin scar characteristics, striae gravidarum score, and ''sliding sign'' on ultrasound have been investigated and found useful to predict adhesions before subsequent surgery[4-6].

Since no data comparing these methods exist, the aim of this study was to evaluate the effectiveness of skin appearance, striae gravidarum severity, and sliding sign for predicting preoperative adhesions before repeat CS on the same patient and to define the best predictive tool.

METHODS

This prospective cohort study was conducted in Bursa Yüksek İhtisas Treaning and Research hospital between December 2020 and August 2021 and approved by institutional ethics committee. Patients who had undergone at least one previous cesarean delivery and scheduled for elective CS were included. Patients with conditions such as pelvic inflammatory disease, infections, wound infections, systemic lupus erythematosus, diabetes, endometriosis, and history of corticosteroid that might affect wound healing were excluded from the study. Demographic data, including age, body mass index (BMI), and smoking status, were also recorded.

Davey's scoring system was applied to determine the severity of the striae gravidarum; thus the abdomen was divided into four quadrants, using the umbilicus as references[7]. If the skin was clear, the score was 0; if the number of striae per quadrant was 1–3, the

score was 1; and if the number of striae was ≤4, the score was 2. The sum of the scores of all four quadrants was calculated to obtain the total striae score. Patients with no striae were classified into the "no striae" group. Patients with the total score of 1–2 were classified into the "mild striae" group, and patients with scores between 3 and 8 were classified into the "severe striae" group.

According to their appearance, the CS scars were classified as flat, elevated, or depressed.

All pregnant women underwent transabdominal ultrasound using Voluson P6 ultrasound system (GE Medical Systems) with a 2- to 5.5-MHz convex probe for the evaluation of sliding sign. The ultrasound assessment was performed by the same physician with 18 years obstetric and gynecological ultrasound experience who evaluated the patient according to Barons' description for sliding sign[6]. The probe was placed just above the transverse skin scar and the patient was asked to take a deep breath in order for the uterus to be observed sliding caudally under the parietal peritoneum and fascia transversalis. Presence of the "sliding sign" was described when sliding of the uterus against the abdominal wall was observed. When no movement of the uterus under the fascia was noted, the sliding sign was considered "absent" (Figure 1).

As a final step, the surgeon who was blinded to the results of the ultrasound sliding sign assessment performed the CS operations and evaluated all patients for intra-abdominal adhesions using the modified Nair classification system[8]. Nair et al., described their classification system as follows: Grade 0: complete absence of adhesions; Grade 1: single band of adhesion between viscera or from one viscera to the abdominal wall; Grade 2: two bands either between viscera or from viscera to the abdominal wall; Grade 3: more than two bands between viscera or from viscera to the abdominal wall; and Grade 4: multiple dense adhesions
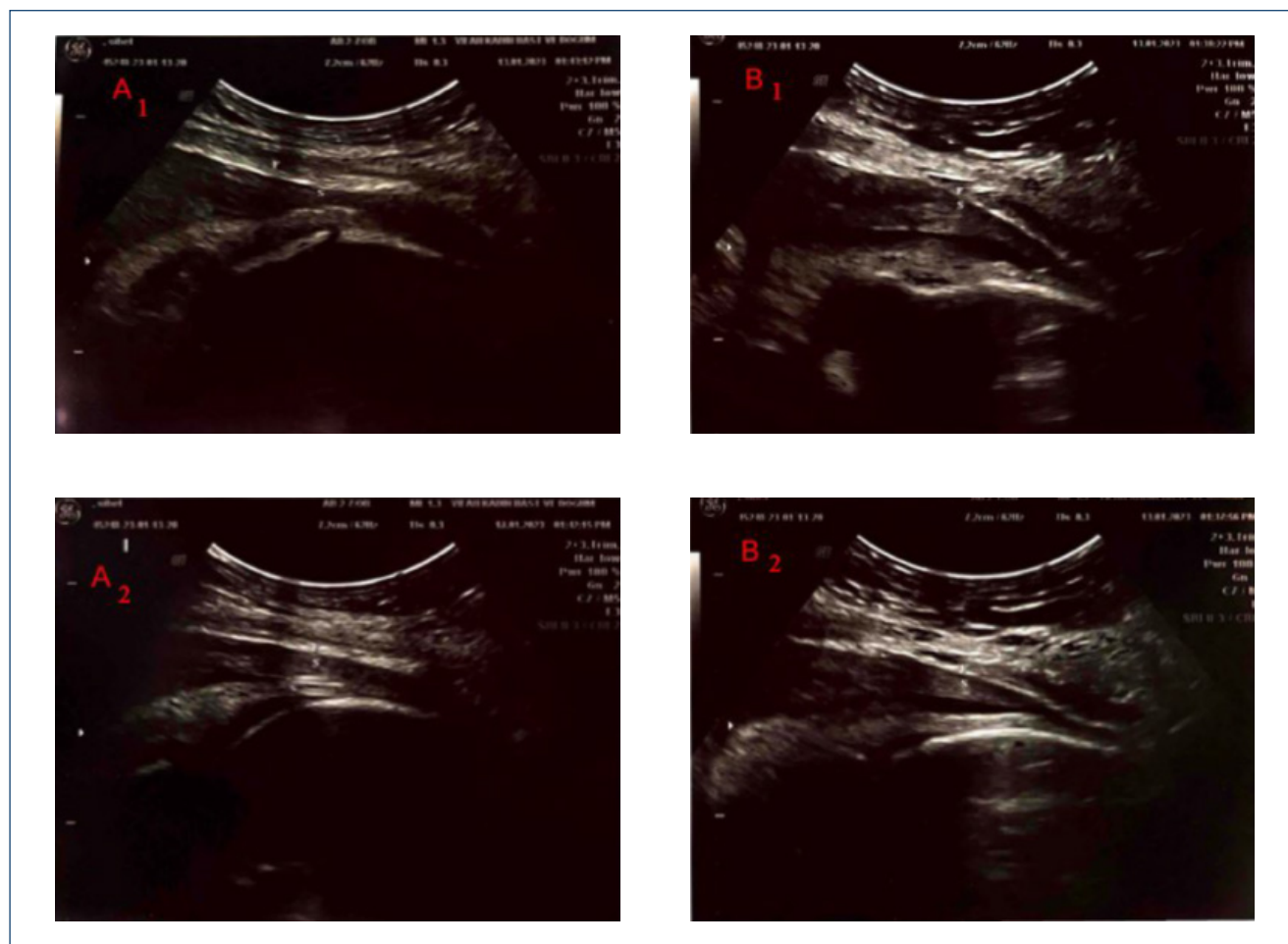

Figure 1. Transabdominal ultrasound images showing the presence or absence of "sliding sign." Top images before deep breath **(A1,B1)**, bottom images after deep breath **(A2,B2)**. "S" represents uterine serosa and "F" represents muscle fascia. **(A2)** After deep breath uterine serosa sliding caudally under the fascia transversalis (positive sliding sign). **(B2)** No movement of the uterus under the fascia transversalis was noted (negative sliding sign).

or viscera directly adherent to the abdominal wall, irrespective of the number or extent of adhesive bands. According to this intraoperative, adhesions were classified as grade 1 or 2 if filmy intra-abdominal adhesions were present and as grade 3 or 4 if dense intra-abdominal adhesions were present.

Statistical analysis

The data were analyzed using the SPSS, version 22.0 program (IBM, Armonk, NY, USA). The descriptive statistics were presented as mean±SD for continuous variables and as a median (minimum-maximum) for discrete numeric variables. Variables were examined using visual (histograms, probability graphs) and analytical methods (Shapiro-Wilk and Kolmogorov-Smirnov test) to determine whether the data showed a normal distribution. Kruskal-Wallis and chi-square tests were used for comparisons between groups. Multiple logistic regression analysis was performed to examine the risk factors affecting the development of adhesion. ROC analysis was performed for the striae score, which was determined as a risk factor, and the cutoff value was determined. A p-value of <0.05 was considered to be statistically significant.

RESULTS

In all, 73 (44.5%) patients had intra-abdominal adhesions (47 had filmy adhesions and 26 had dense adhesions) and 91 (55.5%) were found to have no adhesions. Mean age was 29.6±5.4 years, mean parity was 2 (1–7), and mean BMI was 30.3±5.3. The demographic characteristics of the participants are presented in Table 1. According to adhesion existence, participants were classified into the following three groups: group 1: patients with no intra-abdominal adhesion; group 2: patients with filmy adhesions; and group 3: patients with dense adhesions.

Table 1. Demographic and clinical characteristics of patients.

	Patients (n=164)
Age (years) (mean±SD)	29.6±5.4
BMI (kg/m²; mean±SD)	30.3±5.3
Parity (median; minimum–maximum)	2 (1–7)
Stria score	3.1±3.2
Previous CS number	
1	86 (52.4%)
2	48 (29.3%)
3	23 (14%)
3+	7 (4.3%)

CS: cesarean section.

Among these three groups, there was no significant difference regarding various demographic factors, including age, previous cesarean indication, and BMI. However, a statistically significant association was found between three groups regarding parity, previous cesarean number, smoking status, scar appearance, total stria score, and sliding sign existence (Table 2).

Regarding diagnostic performance in predicting presence of intra-abdominal adhesions in women undergoing repeat CS, the sliding sign was the single most valuable method. A negative sliding sign had a likelihood ratio of 4.198 (95%CI 1.178–14.964) for the detection of intra-abdominal adhesions. Stria score and scar appearance were also valuable for detection of adhesions with likelihood ratio of 1.518 (95%CI 1.045–2.205) and 2.405 (95%CI 0.851–6.796), respectively (Table 3). After the ROC analysis, the cutoff value for stria score was determined as 3.5.

DISCUSSION

To the best of our knowledge, this is the first study to compare the effectiveness of preoperative methods for predicting intra-abdominal adhesions before repeat CS. Evaluating striae score, scar appearance, and sliding sign, we found sliding sign as the most effective prediction tool.

Since this study was conducted in a tertiary teaching and research hospital and we included all adhesions, not just severe adhesions, we have an adhesion rate of 44.5% that may be considered high.

Although there are conflicting data, most of the previous studies suggested stria score, scar appearance, and sliding sign as valuable predictors of intra-abdominal adhesions[6,9-12,13,14].

The association between cigarette smoking and delayed wound healing is well known, and increased adhesion formations after each repeated CS is also expected[5,15]. According to our study, smoking and each CS increase the likelihood of intra-abdominal adhesions by 2.82 and 2.73 times, respectively.

Stria gravidarum is a common skin change among pregnant women. In the past years, many studies have been conducted to investigate the effectiveness of stria score for predicting intra-abdominal adhesions before repeat CS. According to Dogan et al., both adhesion formation and the intensity of adhesions were reduced in the presence of abdominal striae, while another study found no difference in peritoneal adhesions in women with or without striae[5,16]. Jaafar's study suggested that the type of striae rather than its severity is associated with intra-abdominal adhesions and studies such as Abbas et al., and Çakır et al., reported higher rates of intraperitoneal adhesions in women with striae gravidarum[9-11]. Our current study

Table 2. Adhesion status of patients.

		Adhesion			p-value
		No	**Filmy Grade 1-2**	**Dense Grade 3-4**	
Age		29.5±5.3	29.1±5.7	31.1±5.2	0.231
Parity		1 (1–6)	2 (1–6)	2 (1–7)	0.000
BMI		30.0±5.4	30.0±5.0	32.1±5.4	0.175
Previous cesarean number		1 (1–3)	2 (1–4)	2 (1–6)	0.000
Cesarean indication	Elective	29 (17.7 %)	15 (9.1 %)	6 (3.7 %)	0.670
	Emergency	62 (37.8 %)	32 (19.5 %)	20 (12.2 %)	0.430
	No	81 (49.4 %)	34 (20.7 %)	22 (13.4 %)	
Scar appearance	Flat	66 (40.2 %)	26 (15.9 %)	12 (7.3 %)	0.001
	Keloid/hypertrophied	12 (7.3 %)	10 (6.1 %)	1 (0.6 %)	
	Depressed	13 (7.9 %)	11 (6.7 %)	13 (7.9 %)	
Severity of stria	Absent	48 (29.3 %)	17 (10.4 %)	8 (4.9 %)	0.103
	Mild	7 (4.3 %)	2 (1.2 %)	2 (1.2 %)	
	Severe	36 (22 %)	28 (17.1 %)	16 (9.8 %)	
Sliding	Negative	5 (3 %)	5 (3 %)	15 (9.1 %)	0.000
	Positive	86 (52.4 %)	42 (25.6 %)	11 (6.7 %)	
Stria score		2.4±2.9	3.8±3.3	4.3±3.4	0.004

BMI: body mass index.

Table 3. Risk factors for adhesion.

	OR	95%CI	p-value
Parity	1.341	0.634–2.834	0.442
Previous cesarean number	2.733	1.403–5.321	0.003
Stria score	1.518	1.045–2.205	0.028
Smoking status	2.821	1.048–7.595	0.04
Scar appearance			
Flat			
Keloid/hypertrophied	2.405	0.851–6.796	0.098
Depressed	1.211	0.439–3.338	0.712
Severity of stria			
Absent			
Mild	0.327	0.057–1.883	0.211
Severe	0.178	0.015–2.122	0.172
Sliding *R2 Nagelkerke: 0.377	4.198	1.178–14.964	0.027

revealed positive correlation with Davey's striae gravidarum score and intraoperative adhesion existence. After ROC analysis, striae score of 3.5 was found as best cutoff threshold value in adhesion prediction similar to the results of Elprince et al., who suggested stria score ≥3 as cutoff value[16].

Abdominal scar characteristic has been suggested as a possible predictor for intra-abdominal adhesions, suggesting the similarities in healing of skin and peritoneum. Kahyaoglu et al., and Jaafar et al., concluded that depressed scars were the predictors for intra-abdominal adhesions[9,12]. Additionally, elevated and palpable scars were also found to be associated with more adhesions[17]. The present study indicate that both hypertrophied/palpable and depressed scars were associated with intra-abdominal adhesions and support the results of a meta-analysis suggesting that depressed and elevated scars were positively associated with intra-abdominal adhesions, while flat scars were the predictors to determine the absence of adhesions[18].

In recent years, ultrasound has been proposed as suitable, noninvasive tool for adhesion prediction and "sliding sign" was mostly used to predict pelvic endometriosis-related adhesions. Baron et al., were the first to describe this method in predicting intraoperative adhesions before repeat CS and effectiveness of sliding sign was supported by Drukker et al.[6,13,14]. Despite promising results, lack of comparison between the effectiveness of sliding sign with other known adhesion predictors was the main limitation of these studies. In this study, we investigated and compared the effectiveness of most known adhesion predictors and showed that the sliding sign predicted intra-abdominal adhesions before repeat CS more accurately than other predictors including stria score, scar appearance, and previous cesarean number.

Ultrasound is easily accessible, commonly used noninvasive diagnostic tool in obstetrics and gynecology practice. After a short learning period, it can be applied preoperatively by physicians for the detection of sliding sign. Skin appearance, stria score, and previous CS number were also significant predictors of adhesion, therefore using them together with sliding sign can improve accuracy of intraoperative adhesion prediction before repeat CS.

Using blinded prospective design, utilizing standardized scoring systems, investigating and comparing the effectiveness of these methods on the same patient are the main strengths of the present study. The main limitations are small sample size and not evaluating all known diagnostic tools for adhesion prediction.

In conclusion, predicting intra-abdominal adhesions in pregnant women undergoing a repeat cesarean delivery is still a challenging issue in obstetric practice. Stria score, scar appearance, and sliding sign are all significant predictors for intraperitoneal adhesions. Furthermore, sliding sign, as an easy-to-apply, inexpensive, useful sonographic marker, is the most effective adhesion predictor compared to other known adhesion markers.

AUTHORS' CONTRIBUTIONS

SS: Data curation, Formal Analysis, Project administration, Resources, Visualization, Writing – original draft. **BA**: Formal Analysis, Supervision, Visualization, Writing – original draft. **SSK**: Conceptualization, Formal Analysis, Methodology, Supervision, Writing – original draft.

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