

Sliding Sign for Intra-abdominal Adhesion Prediction Before Repeat Cesarean Delivery 1

Lior Drukker, MD, Hen Y. Sela, MD, Orna Reichman, MD, Ron Rabinowitz, MD, Arnon 2

Samueloff, MD and Ori Shen, MD 3

From the Department of Obstetrics and Gynecology, Shaare Zedek Medical Center, affiliated 4

with the Hebrew University Medical School, Jerusalem, Israel 5

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Corresponding author 7

Hen Y. Sela, MD, Department of Obstetrics and Gynecology, Shaare Zedek Medical Center, 8

Affiliated with the Hebrew University Medical School. 12 Bayit Street, Jerusalem 91031, Israel; 9

email: hysela@szmc.org.il 10

T: +972-2-655-5562 11

F: +972-2-666-6053 12

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Précis

A negative sliding sign between the abdominal wall and the uterus before repeat cesarean

delivery can aid in the prediction of severe intra-abdominal adhesions.

ABSTRACT 25

BACKGROUND: The sliding sign (the relative motion between the abdominal and uterine wall as assessed by ultrasonography) may help identify severe intraabdominal adhesions before repeat cesarean delivery. 26
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METHODS: We conducted a prospective observational study of scheduled repeat cesarean deliveries. Using transabdominal ultrasonography, while the parturient breathed deeply, the ultrasonographer recorded a video clip in a sagittal plane lateral to the umbilicus. These clips were assessed for the presence (sliding-positive) or absence (sliding-negative) of relative movement between the maternal abdominal and uterine wall. Surgeons blinded to ultrasonography results graded the severity of intraperitoneal adhesions intraoperatively. Study outcomes were the accuracy of the preoperative sliding sign for prediction of severe adhesions and its association with surgical times and bleeding. 29
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EXPERIENCE: We recruited 370 women. A negative sliding sign was associated with severe adhesions (sensitivity 56%, 95% CI 35–76; specificity 95%, 95% CI 93–97). A similar accuracy (sensitivity 64%, 95% CI 43–82; specificity 94%, 95% CI 92–97) was achieved by combining the sliding sign with a history of adhesions in the previous surgery. In multivariable models, a negative sliding sign was significantly correlated with a longer interval from skin incision to delivery and increased risk for bleeding. 37
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CONCLUSION: A negative sliding sign predicts severe intra-abdominal adhesions encountered during repeat cesarean delivery, longer time to delivery, and a higher chance of bleeding. 43
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INTRODUCTION

The incidence of repeat cesarean delivery is on the rise worldwide; in the United States, approximately 90% of women with a prior cesarean delivery undergo planned repeat cesarean delivery in their next pregnancy. (1) Intra-abdominal adhesions are frequently encountered during repeat cesarean delivery and are aggravated in prevalence and severity in multiple repeat cesarean delivery. (1) Adhesiolysis may result in lengthy fetal extraction, injury to adjacent viscera, and blood loss.

Currently, surgeons lack a reliable method for the preoperative prediction of intra-abdominal adhesions in repeat cesarean delivery. (2) Several strategies have been suggested, including skin scar visual characteristics (2) and surgical history. (3) However, these methods suffer from lack of reproducibility, and there is often no relevant history before the first repeat cesarean delivery. (4) Hence, whether a specific woman before a repeat cesarean delivery is at risk for severe intraabdominal adhesions remains unknown. Women suspected to have severe intra-abdominal adhesions may benefit from appropriate preparation of blood products, better assignment of surgeons, request for preoperative surgical assistance of other medical specialties, and possibly performance of a midline skin incision to enter the peritoneal cavity. The sonographic sliding organ sign has been shown to have high predictive value for the detection of pelvic adhesions in women with endometriosis and chronic pelvic inflammation as well as infraumbilical adhesions before laparoscopic surgery. (5, 6)

The goal of the present study was to evaluate the use of the ultrasonographic uterine sliding sign to predict severe intra-abdominal adhesions in patients scheduled for a planned repeat cesarean delivery.

METHOD

We conducted a prospective blind observational study at a single tertiary center between March 2016 and December 2016. We enrolled all women with a planned repeat cesarean delivery regardless of indication. We excluded patients with body mass index (BMI, calculated as weight (kg)/[height (m)]²) greater than 40 on admission and those with invasive placentation. Women who underwent unplanned repeat cesarean delivery as a result of urgency were also excluded from this study because they might not have undergone complete preoperative assessment. The institutional ethics committee (#0243-15) approved the study protocol.

As a result of the high rate of transfers to the hospital, all women scheduled for repeat cesarean delivery undergo preoperative transabdominal ultrasound examination in the supine position by a sonographer with more than 10 years of experience in obstetric ultrasonography. All examinations were performed using Voluson E8 and E10 systems. With the transducer positioned on the abdomen at the level of the umbilicus lateral to the midsagittal plane, the woman was asked to take several deep breaths and exhale while the sonographer recorded a clip. Subsequently, two experienced sonographers (L.D. and O.S.), blinded to patient data, independently viewed the recordings and classified a positive sliding sign if the anterior uterine wall was seen sliding across the abdominal wall (Video 1, available online at <http://links.lww.com/AOG/B63>) and a negative sliding sign when there was no such relative motion (Video 2, available online at

<http://links.lww.com/AOG/B64>). Disputes between the sonographers were resolved by mutual agreement. 88
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Surgeons were unaware of sonographic sliding sign status and used clinical judgment to make decisions related to the cesarean delivery. Irrespective of this study, surgeons routinely report the grade of intra-abdominal (peritoneal level) adhesions encountered during cesarean delivery in the surgical note. Adhesions were graded according to severity using a standardized scoring system: 0—no adhesions, 1—minimal or filmy adhesions, 2—moderate or thick adhesions, and 3—absence of free space between the uterus and the anterior abdominal wall. (7) All residents receive training to ensure standardization of the scoring system. If in doubt about the grade of adhesions, the resident consults the senior surgeon. At the time of admission, the following prospective data were collected: patient demographic parameters, diagnosis, and surgical history. After the surgery, we reviewed the surgical notes and postpartum course. 90
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Based on surgical findings, patients were categorized into two groups: patients with severe adhesions (grade 3) and patients with nonsevere or no adhesions (grades 0–2). 100
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The primary study outcome was the correlation between a negative sliding sign and severe adhesions. Secondary outcomes were the association between a negative sliding sign and operative times (skin incision to delivery and overall time from skin incision to skin closure) and hemoglobin drop greater than 3 g/dL (calculated between preoperative and postoperative hemoglobin levels). 102
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Based on general surgery literature, (8) we expected that the sensitivity for prediction of severe adhesions would be 70% and anticipated that the lowest acceptable sensitivity would be 50%. According to a recent systematic review, the prevalence of severe adhesions (grade 3) is 6%.(9) Therefore, the sample size calculation was based on the number of screening 106
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ultrasonograms required to ensure that the lower limit of the 95% CI for sensitivity did not fall 110
below 50%. The required sample size was calculated to be 351 patients. (10) 111

Two-by-two tables were constructed for categorical variables. Univariate analysis was 112
performed for categorical variables using χ^2 or Fisher exact test, as appropriate. Continuous 113
variables were compared using the Student t test or Mann–Whitney U test, as appropriate. The 114
sensitivity, specificity, and positive and negative likelihood ratios were calculated for a negative 115
sliding sign in relation to the presence of severe intra-abdominal adhesions. To evaluate the 116
independent association between the sliding sign and operative times, we conducted a linear 117
regression model a priori adjusting for factors that we considered to be strongly related to the 118
sliding sign and to the length of surgery: past postpartum hemorrhage, parity, number of previous 119
cesarean deliveries, and grade of adhesions. To evaluate hemoglobin drop, multivariable 120
backward, stepwise logistic regression models were performed. Independent candidate variables 121
were past postpartum hemorrhage, parity, number of previous cesarean deliveries, and grade of 122
adhesions. Adjusted odds ratios (ORs) and 95% CIs are reported. All tests are two-tailed; P value 123
<.05 was considered statistically significant. Analyses were carried out using SPSS 20.0. 124

EXPERIENCE 125

During the study period, there were a total of 1,320 cesarean deliveries. After exclusions, 370 126
(28.0%) women were included (Fig. 1; Table 1). Severe adhesions were encountered in 6.8% 127
(25/370) of the women. 128

A negative sliding sign had a sensitivity of 56% (95% CI 35–76), specificity of 95% (95% 129
CI 93–97), a positive likelihood ratio of 12.1 (95% CI 6.7–21.8), and a negative likelihood ratio 130
of 0.46 (95% CI 0.30–0.72) for the detection of severe adhesions. The sensitivity was similar 131

($P=.75$) when we combined both the current sliding sign and history of severe adhesions recorded in the previous cesarean delivery surgical notes (Table 2).

A multivariable logistic regression model showed a significantly elevated risk of bleeding (hemoglobin drop greater than 3 g/dL) in women with a negative sliding sign (adjusted OR 4.09, 95% CI 1.22–13.72, $P=.02$) compared with those with a positive sliding sign. Adjusted linear regression showed that the skin incision to delivery interval was significantly longer, by 6.7 minutes (95% CI 3.3–10.0, $P<.001$), in women with a negative sliding sign compared with those with a positive sliding sign. The median time interval from skin incision to skin closure was not significantly longer in women with a negative sliding sign compared with those with a positive sliding sign (36 minutes [interquartile range 27–49 minutes] vs 45 minutes [interquartile range 35–75 minutes]; $P=.26$).

The interobserver agreement was calculated for evaluation of the sliding sign. Overall, there were seven cases of disagreement, which were resolved by discussion and mutual agreement. The strength of agreement was very good with a k of 0.87 (95% CI 0.78–0.97). The intraobserver agreement was not studied.

DISCUSSION

We found that a negative uterine sliding sign is correlated with severe intra-abdominal adhesions. A stronger correlation was achieved by combining the sliding sign with a history of previous cesarean delivery adhesions. According to our findings, a negative sliding sign predicts a significantly longer time from skin incision to delivery and bleeding, possibly reflecting more challenging surgery.

Applying a preoperative transabdominal ultrasonogram for the detection of severe intra-abdominal adhesions has the advantage of simplicity. The ability to predict severe adhesions,

based on a negative sliding sign, can possibly result in better planning and safer conduct of surgery, 155
including an improved perioperative decision-making process concerning the timing of surgery, 156
surgeon seniority, anesthetic team, type of anesthesia, surgical technique, and preparation of blood 157
products. This may be similar to the surgical preparations, technique, and the high level of care 158
required in women who are suspected of having invasive placentation. (11) Furthermore, the 159
presence of severe adhesions could potentially be part of the consultation before a trial of labor 160
after cesarean delivery. Such women may be booked for a repeat cesarean delivery or advised to 161
attempt a trial of labor after cesarean delivery at a center equipped with facilities required for an 162
emergency cesarean delivery complicated by severe adhesions. 163

The main strengths of our study include its originality and blinded prospective design. 164
Study limitations include 1) the subjective nature of ultrasound interpretation; the sliding sign was 165
classified as either positive or negative and did not allow for intermediate findings; 2) based on 166
personal experience, we evaluated the sliding sign at one position. However, it is possible that 167
severe adhesions are better predicted at other locations; 3) the scope of this study was to evaluate 168
the correlation between severe adhesions and a negative sliding sign because the presence of 169
severe adhesions is a risk factor for cesarean delivery complications. (12) Adhesion grading was 170
based on surgical notes that may lack consistency between surgeons; in addition, the inter- and 171
intraobserver variabilities of intra-abdominal adhesion assessment at repeat cesarean delivery are 172
unknown; 4) ultrasound scans and their interpretation in this study were performed by experts 173
using top-of-the-range ultrasound equipment; and 5) the accuracy of ultrasonography highly 174
correlates with the abdominal wall thickness. Because morbidly obese parturients account for 175
approximately 11% of repeat cesarean deliveries, we included only women whose BMI was below 176

40; hence, the accuracy of the sliding sign in women with a BMI greater than 40 remains to be 177
determined. 178

In conclusion, we present a rapid and easy-to-perform method to identify severe intra- 179
abdominal adhesions in women undergoing a repeat cesarean delivery. The best accuracy is 180
achieved by using a combination of sliding status and documentation, when available, of prior 181
cesarean delivery adhesions. 182

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- Figure 1:** Women included in this study. BMI, body mass index 215

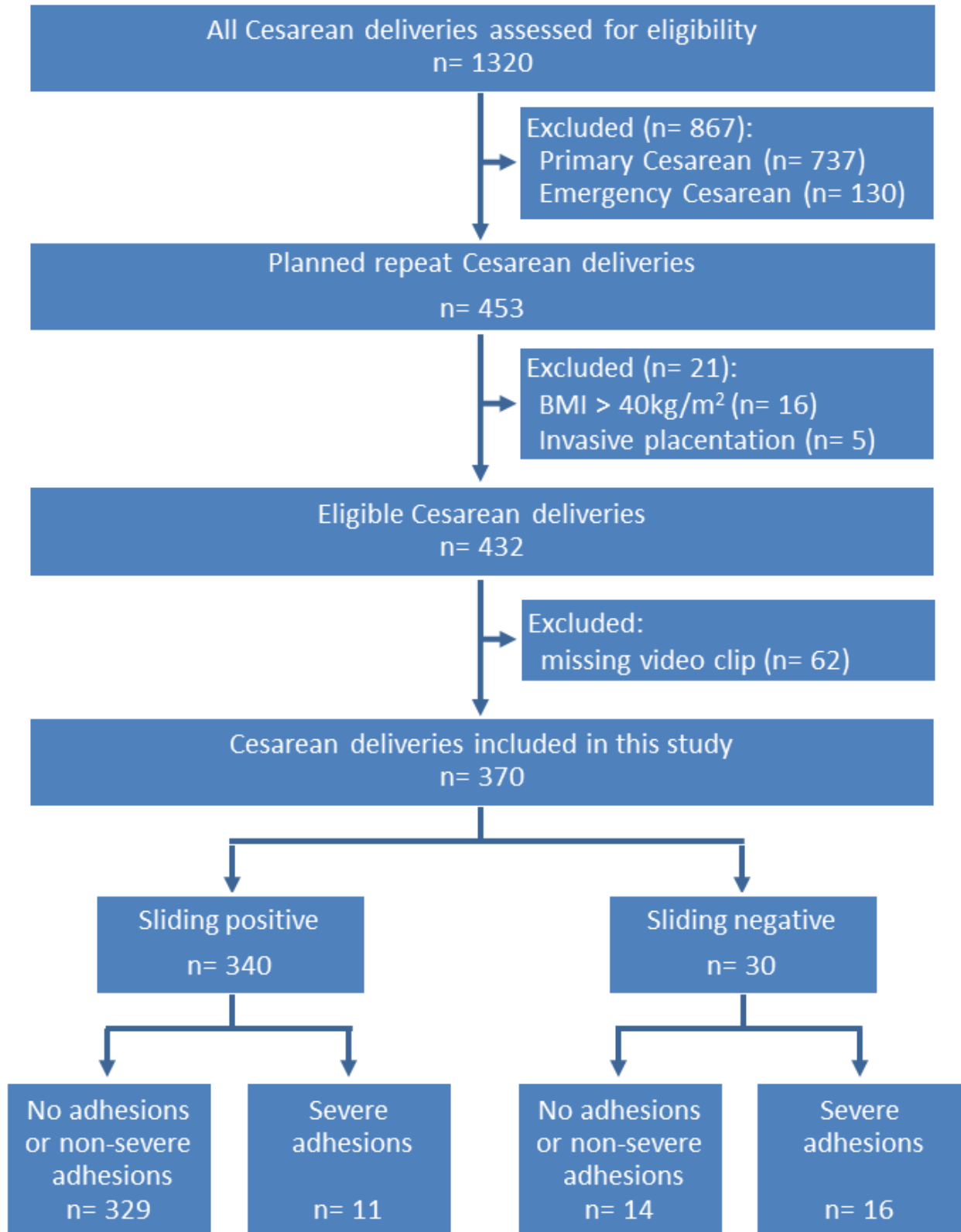


Table 1. Demographic, Gestational Characteristics and Outcome of Study Participants (n=370)

Characteristic	Value
Maternal	
Age (y)	34.4 ± 5.1
Previous Cesarean deliveries	
1	112 (30.3)
2	135 (36.5)
3 or more	123 (33.2)
Severe (grade 3) adhesions in previous cesarean delivery*	11 (3.2)
BMI at delivery (kg/m ²)	30.9 ± 5.5
Gestational	
Multifetal gestation	15 (4.1)
Diabetes mellitus (pregestational and gestational)	36 (9.7)
Hypertensive disorder	9 (2.4)
Outcome	
Skin incision to delivery interval (min)	9 (5 – 12)
Skin incision to skin closure (min)	36 (29 – 50)
Gestational age at delivery (wk)	38 (37 – 38)
Hemoglobin drop greater than 3 gr/dL	20 (5.4)
Packed red blood cells transfusion	8 (2.2)
Relaparotomy	1 (0.3)

BMI, Body Mass Index.

Data are mean ± standard deviation; number (%); median (interquartile range).

* Previous cesarean delivery adhesions history is missing for 29 (out of 370) women.

Table 2. Diagnostic Performance for the Detection of Severe Intra-abdominal Adhesions in Women With Repeat Scheduled Cesarean Delivery

	Sensitivity	Specificity	LR+	LR-
Negative sliding sign	56 (35 – 76)	95 (93 - 97)	12.1 (6.7 – 21.8)	0.46 (0.30 – 0.72)
Previous CD severe adhesions	33 (16 – 55)	99 (97 – 100)	35.2 (10.0– 124.2)	0.67 (0.51 – 0.89)
Negative sliding sign or previous CD severe adhesions*	64 (43 – 82)	94 (92 – 97)	11.6 (6.9 – 19.7)	0.38 (0.23 – 0.64)
Negative sliding sign and previous CD severe adhesions*	27 (11 – 50)	100 (99 – 100)	--	0.73 (0.56 – 0.94)
LR+, positive likelihood ratio; LR-, negative likelihood ratio; CD, Cesarean delivery.				223
Data are % (95% CI) or likelihood ratio (95% CI).				224
* Calculated for 341 (of 370) women because previous cesarean delivery adhesions history was unknown in 29 women.				225
				226