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Accuracy of sliding sign for prediction of adhesions in repeated cesarean section in third trimester and Intra-operative adhesion complications

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RESEARCH ARTICLE

ABSTRACT

Objective: Repeated cesarean sections (CS) are the common etiology of intra-abdominal adhesion formation with increased operating time and blood loss. Because of the necessity of a preoperative diagnosis, we decided to evaluate the sensitivity, specificity and predictive values of sliding sign in abdominal ultrasound in repeated CS for intra-abdominal adhesion diagnosis. *Method:* This study was performed on pregnant women with at least one previous CS in the third trimester. The movement of the outer surface of the myometrium relative to the inner surface of the abdominal fascia was evaluated by abdominal ultrasound for sliding sign. If the patient had sliding sign, the patient was low risk. In the absence of sliding sign, the patient was high risk. Then the questionnaire was filled out according to the CS findings and data was entered into analysis stage. *Results:* In the negative sliding sign group, the number of CS was higher than the positive sliding sign that was statistically significant (1.7 vs 1.4, p value=0.026). The higher the adhesion degree, the longer incision and delivery time and the lower 1-minute Apgar score (P = 0.0001). Of the 37 cases with adhesion, 25 did not have sliding sign, and the sensitivity was 68%. Of the 170 cases without adhesion, sliding was seen in 164 cases; with specificity 96.5% (positive and negative predicting values were 52% and 98%, respectively). *Conclusion:* Sliding sign by abdominal ultrasound could be an accurate and easy diagnostic tool in predicting intra-abdominal adhesion, especially in severe cases.

Keywords: repeated cesarean, intra-abdominal adhesion, sliding sign

1. INTRODUCTION

The fibrous bands formed between the organs and the abdominal walls are called adhesions. Approximately 90% of intra-abdominal adhesions are due to intra-abdominal surgery of which laparotomy is the most important one (Tabibian, 2017). Despite the significant decline in births in recent years, cesarean rate still remains high. Data shows the CS percentage in the United States is 31.9% in 2018 (Martin, 2018). According to a meta-analysis in 2014, the total prevalence of CS in Iran was 48% (Azami, 2014). The rate of adhesion formation increases with the number of previous CS, so that in the second repeated cesarean the adhesion rate is low and in the range of 24 to 46%, while in the third repeated cesarean it reaches to 43 to 75% and in the case of the fourth CS to 83% (Awonuga, 2011). In Iran, the incidence of intra-abdominal adhesion after CS was estimated 32% and the rate of dense adhesion and frozen pelvis was 15.6 % (Yaghmaei, 2018).

Adhesions cause some complications such as bowel obstruction, urinary tract injury, infertility, risk of ectopic pregnancy, chronic pelvic pain, increased operating time (Awonuga, 2011; Poole, 2013), delayed delivery of the infant (Nuamah, 2017; Morales, 2007). In one study, in cases of repeated CS complications were more than twice for example bladder injury, intestinal damage, wound infection, and hysterectomy (Tulandi and Agdi, 2009). Inta- operative adhesions, not only prolong the surgical time and worsen blood loss, but also increase the length of recovery and hospital stay, re-admission and cost imposition to the health system (ten Broek, 2013). A history of surgery, inflammatory diseases and radiation are suggestive for adhesion. There is no specific laboratory test to detect adhesion and imaging findings cannot be definitively diagnostic unless the findings indicate intestinal obstruction (Tabibian et al., 2017). Some authors have used methods such as cesarean scar characteristics and assessment of striaegravidarum to diagnose and evaluate the severity of post-cesarean adhesion (Stocker, 2016; Taylan, 2017; Tulandi and Al-Sannan, 2011; Ahmed, 2011).

Currently, one of the methods considered is the ultrasound dynamic techniques such as abdominal ultrasound or vaginal ultrasound (Reid, 2013; Ayachi, 2018; Alfaraj, 2019). In two studies adhesions were predicted in pregnant women before CS by sliding sign in abdominal ultrasound with acceptable sensitivity and specificity (Baron, 2018; Drukker, 2018). Pelvic ultrasound shows uterine adhesion at the site of cesarean scar to the anterior abdominal wall as the uterus protrudes through a gap between the rectus abdominal muscles. The rectus sheath is seen as an echogenic line above the muscle (El-Shawarby, 2011). Different techniques for CS were proposed by Dr. Wright to reduce the amount of adhesion caused by surgery (Bates, 2011). Although the

adhesion rate is lower in CS with modified Stark method than other cases, in all surgical methods there is a chance of adhesion (Shi, 2011). Due to the high incidence of CS and its complications and to minimize the risk for mothers, it is important to recognize a high-risk patient, including a patient with a history of adhesion in the abdomen and pelvis. When prenatal intra-abdominal adhesions are predicted, planning is made to provide the necessary preparations such as blood products, availability of other required surgical specialties, and decisions about the incision type (Midline or Pfannenstiel) before surgery.

To illustrate the necessity of a diagnostic method, we investigated intraoperative complications due to adhesion in this study. Then according to the importance of a preoperative diagnosis, we decided to evaluate the sensitivity, specificity and predictive values of sliding sign in abdominal ultrasound as a diagnostic method in repeated CS in third trimester to predict intra-abdominal adhesions.

2. MATERIAL AND METHODS

The type of research was a prospective observational study. Pregnant women with a history of at least one CS in the third trimester were participated in the study. All pregnant women who had elective CS due to repeated CS will be community for surveillance. The study was conducted in three university hospitals for one year from January 2018 to January 2019. Inclusion criteria were pregnant women with positive history of at least one CS in third trimester. Exclusion criteria were patients with a known history of collagen diseases or placenta accreta spectrum. Prior to ultrasound, informed consent was obtained from patients for participation, abdominal ultrasound examination and included in the study. The study was approved by ethics committee of our university (No: IR.TUMS.MEDICINE.REC.1398.490).

Ultrasound examination of the patient was performed in the supine position. The patient was not asked to empty the bladder unless the patient feels uncomfortable with the full bladder. Abdominal ultrasound was performed by a single sonographer (maternal- fetal medicine specialist). The Ultrasound machines used was Philips, affiniti 70 and curved abdominal transducer C6 -2. At the level of the umbilicus and lower abdominal area, bilateral to the midsagittal line the probe was positioned vertically, and the patient performs deep inhalation and exhalation. The movement of the outer surface of the myometrium relative to the inner surface of the abdominal fascia was evaluated by at least one centimeter of displacement. If the patient had a displacement (positive sliding), the patient was in the low risk category and in the absence of displacement (negative sliding) the patient was in the high risk category (Figure 1, supplementary video 1 (URL: https://www.facebook.com/100053676980798/videos/114077107058188/) and supplementary video 2 (URL: https://www.facebook.com/100053676980798/videos/114087073723858/)). During the ultrasound procedure the film was taken, which could also be reviewed. The duration of the ultrasound was short, about several minutes, and could be performed simultaneously with other third trimester ultrasound.

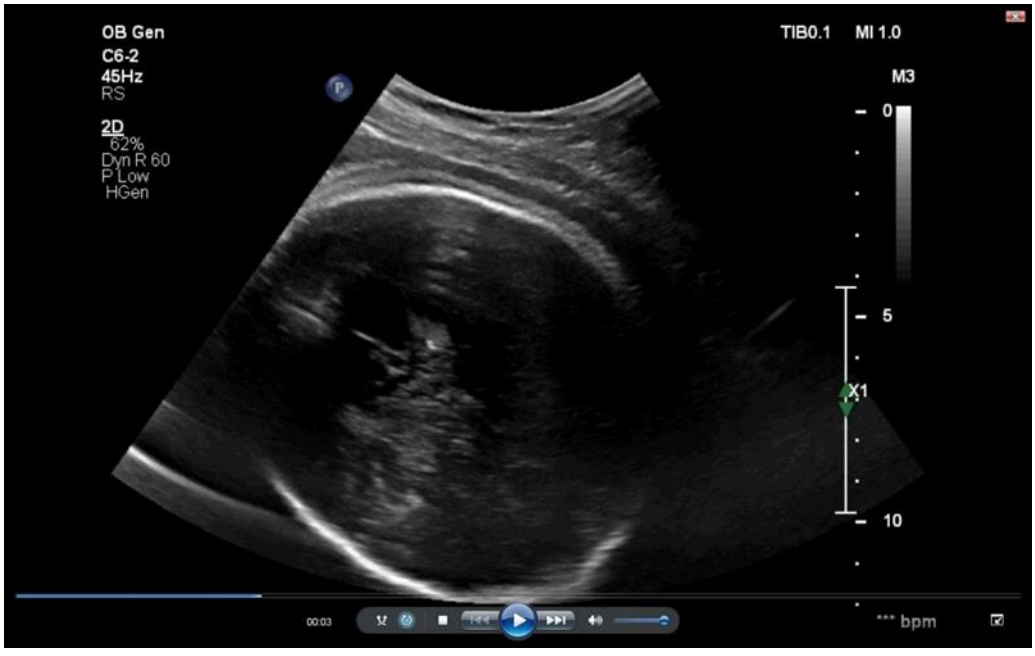

Figure 1 The ultrasound probe is located in the middle line between the umbilicus and the symphysis of pubis vertically.

Sliding sign is evaluated according to the slip between the fetal presenting part and the internal fascia of the rectus muscle while the mother is breathing deeply.

Then the questionnaire was filled out according to the CS procedure findings by up to 3 surgeons already trained in adhesion and degree of adhesion. The decision of the trained surgeon was the main or golden test. The adhesion grading was as follows:

Degree 0 = equal to no adhesion, grade 1= minimal and very thin adhesion, grade 2 = high thickness adhesion, and grade 3 = severe adhesion if there was no cleavage plane between the abdominal wall and uterus and viscera. Surgeons were blinded to the results of ultrasound scan and also sonographer was blinded to the surgical finding to prevent bias. If there was any doubt about the degree of adhesion, a second surgeon would be consulted. The questionnaires were then completed and entered the statistical analysis.

The main objective of this study was to determine the sensitivity and specificity of the sliding sign in detecting intra-abdominal adhesion before CS. Secondary objectives of the study are: evaluation of sliding sign based on parity, previous CS and history of abdominal and pelvic surgery, evaluation of adhesion during CS based on parity, previous CS and history of abdominal and pelvic surgery, comparison of mean skin incision time to uterine incision (incision time) and mean skin incision time to delivery (delivery time) and 1 and 5 minute Apgar score between patients with and without abdominal adhesion and evaluation of intra-abdominal adhesion based on the last two cesarean sections interval.

Statistical analysis

Studies have found that the sensitivity of this test for adhesion assessment in repeated CS was 56-76%. On the other hand, it is estimated that the adhesion frequency during surgery to be 24-46%. According to the sensitivity estimation formula with 95% confidence of at least 205 sample of eligible CS should be studied.

$$n = (Z_{1-\frac{\alpha}{2}})^2 S_N(1-S_N) \Big/ \varepsilon^2 \times pre$$

$$Z_{1-\alpha/2} = 1.96$$
$$S_N = 0.75$$
$$\varepsilon = 0.1$$
$$pre = 0.35$$

Data was entered into SPSS. Descriptive statistics for qualitative variables were expressed as absolute and relative abundances and for quantitative variables as mean and standard deviation. Analytical statistics on the estimation of sensitivity and specificity were derived on the basis of 2 * 2 tables with appropriate statistical tests such as chi square. Sensitivity, specificity, and positive and negative predictive value of sliding sign were calculated. Mann-Whitney and Kruskal-Wallis tests were used to compare the means and numerical variables. Comparison of the qualitative and nominal variables was performed by chi-square test. Univariate Analysis of Variance was used to show the difference in mean incision time, delivery time, and first minute Apgar score at different degree of adhesion.

3. RESULTS

Of the 240 pregnancies with a history of CS, 23 were excluded because of inappropriate video, invalid questionnaire information, or CS at another center. The mean age of the women who participated in the study was 33.4 years and the mean gestational age was 35.2 weeks (Table 1).

Table 1 Demographics of Participants (N=207)

	mean	median	SD	minimum	maximum
Maternal age(year)	33.41	33	4.7	24	44
Gestational age (week)	35.2	36	3.2	28	39
BMI	27.06	26.81	4.2	18.30	38.95
Parity	1.48	1	0.7	1	4
Number of previous c/s	1.44	1	0.7	1`	4
c/s interval(year)	5.8	5	3.6	0.8	19

BMI, body mass index

SD, standard deviation

Out of these 217 patients, 113 had previous emergency CS, while 94 had elective CS. The previous median incision was seen in 4 cases of previous CS. Of patients with a history of previous surgery other than CS, 13 (41.9%) had a history of abdominal surgery (laparotomy) and 18 (58.1%) had a pelvic surgery.

In this study, adhesion was observed in 17.9% (37/207) of cases of cesarean.17 (8.2%) cases were classified as mild and 20 (9.6%) as moderate to severe. Positive and negative sliding sign were found in176 (85%) and 31 (15%) of cases, respectively (Table 2).

Table 2 Frequency table of variables

		frequency	Percent (%)
History of c/s type	emergency	113	54.6
	elective	94	45.4
Type of incision	pfannestiel	203	98.1
	median	4	1.9
placenta	anterior	101	48.8
	posterior	87	42
	fundal	9	4.3
	lateral	7	3.4
	mix	3	1.4
History of laparotomy	abdominal	13	41.9
	pelvic	18	58.1
History of post op complication	hematoma	1	0.5
	transfusion	1	0.5
Sliding sign	positive	176	85
	negative	31	15
Adhesion	total	37	17.9
	grade1	17	8.2
	grade2	4	1.9
	grade3	16	7.7

The normality of the variables was determined by Kolmogorov-Smirnov test. In this study, almost all variables followed the non-normal distribution. Mann-Whitney test and the Kruskall-wallis test were used for comparison between the two groups. In the group with negative sliding sign, the number of CS was higher than the positive sliding group (table 3) and was statistically significant (1.7 vs 1.4, p value=0.026).

Table 3 Comparison between the two sliding groups in terms of numerical variables

Sliding sign		gravid	parity	Gestational age	BMI	CS number	Laparotomy number
yes	Mean	2.90	1.44	34.20	26.95	1.40	0.15
	N	176	176	176	176	176	176
	SD	1.05	0.76	3.30	4.08	0.70	0.39
	Median	3	1	36	26.71	1	0
no	Mean	3	1.71	35.32	27.73	1.71	0.23
	N	31	31	31	31	31	31
	SD	1.21	0.86	2.99	4.93	0.86	0.50
	Median	3	1	36.29	27.63	1	0
total	Mean	2.91	1.48	35.22	27.07	1.44	0.16
	N	207	207	207	207	207	207
	SD	1.08	0.78	3.25	4.21	0.73	0.41
	Median	3	1	36	26.81	1	0
	P.value*	0.71	0.054	0.90	0.58	0.026	0.44

*NPar Tests-Mann-Whitney Test

BMI, body mass index; N, number of patients; SD, standard deviation

Table 4 shows that the number of previous cesarean sections was significantly higher in the adhesion group (1.7 vs 1.3, p value=0.001) and the number of parity was higher in this group either (1.7 vs 1.4, p value=0.012).

Table 4 Comparison between the two adhesion groups in terms of numerical variable

Adhesion		Age	Gestational Age	Gravid	Parity	BMI	CS number	Laparotomy number
yes	Mean	32.81	35.54	3.11	1.76	27.77	1.78	0.14
	N	37	37	37	37	37	37	37
	SD	4.25	3.22	1.17	0.90	4.37	0.89	0.44
	Median	33	37	3	2	27.63	2	0
no	Mean	33.54	35.15	2.87	1.42	26.91	1.37	0.16
	N	170	170	170	170	170	170	170
	SD	4.83	3.26	1.05	0.74	4.17	0.68	0.40
	Median	33.50	36.00	3	1	26.55	1	0
Total	Mean	33.41	35.22	2.91	1.48	27.07	1.44	0.16
	N	207	207	207	207	207	207	207
	SD	4.73	3.25	1.08	0.78	4.21	0.73	0.41
	Median	33	36	3	1	26.81	1	0
	P.value*	0.34	0.44	0.2	0.012	0.33	0.001	0.818

*NPar Tests-Mann-Whitney Test

BMI, body mass index; N, number of patients; SD, standard deviation

There was no significant relationship between CS interval and presence or absence of adhesion (P=0.693) and also between different adhesion degree (P=0.894). There was no statistically significant relationship between adhesion formation and type of surgery except CS. Adhesion was observed in 15.5% in abdominal versus 16.5% in pelvic surgery (p =0.924). There was no statistically significant relationship between the severity of adhesion and the type of previous surgery. In 8% of abdominal surgeries there was severe adhesion compared to 11% of pelvic surgeries (p=0.10).

Table 5 Mean incision time and delivery time by degree of adhesion

Adhesion Degree		Incision time	Delivery time
0	N	170	170
	Mean (min)	4.3	6.6
	SD	1.6	1.8
1	N	17	17
	Mean(min)	5.5	8.2
	SD	3	3
2	N	4	4
	Mean(min)	9.1	11.8
	SD	2.8	3.1
3	N	16	16
	Mean(min)	11.2	14.9
	SD	3	3
Total	N	207	207
	Mean (min)	5.1	7.4
	SD	3	3

N, number of patients; SD, standard deviation

Significantly longer incision time and delivery time were noted in the group with higher degree of the adhesion (average of 8 minutes incision time in cases of adhesion versus 4 minutes mean in case of non-adhesion and mean delivery time of 11-minutes in cases of adhesion vs. 6.59 minutes in cases of non- adhesion). Univariate Analysis of Variance shows that this difference is significant. The higher the adhesion degree, the longer incision time (P = 0.0001). Post hoc tests shows significantly higher incision time was noted in 2nd and 3rd degree adhesion than non-adhesion as well as 1st degree adhesion. But there was no significant relationship between first degree and no adhesion (Table 5).

We also demonstrated that the higher the adhesion degree, the longer delivery time (P = 0.0001). Even this difference between non-adhesion and even grade 1 adhesion can be seen. The higher the adhesion degree, the lower is 1-minute Apgar score (P = 0.0001). Post Hoc Tests was used to determine the first minute Apgar difference between each degree of adhesion. This test shows that only 1-minute Apgar score in grade 3 adhesions was significantly reduced compared to non-adhesion group, and that there was no significant difference between other grades. This relationship was not seen in the 5-minute Apgar score.

In adhesion group, only 2 cases (5.4%) received transfusion, whereas 35 cases (17.5%) did not. The transfusion requirement in the adhesion group was 5% vs. 3% in the non-adhesion group. (p = 0.618). Although the transfusion requirement was higher in the adhesion group, it was not statistically significant. Of the people with adhesion (37 cases), 25 did not have sliding sign, and the sensitivity of sliding sign for adhesion detection was 68%. Of the 170 cases without adhesion, sliding was seen in 164 cases, with a specificity of about 96.5%. Positive predictive value (PPV) was 81% and negative predictive value (NPV) 93%. Among those with severe adhesion (20 cases), 16 sliding sign were not detected and the sensitivity of the test for diagnosis of severe adhesion was 80%. Of the 187 cases without severe adhesion (without or mild adhesion) sliding was seen in 172, the specificity was about 92% PPV 52% and NPV 98% (Figure 2).

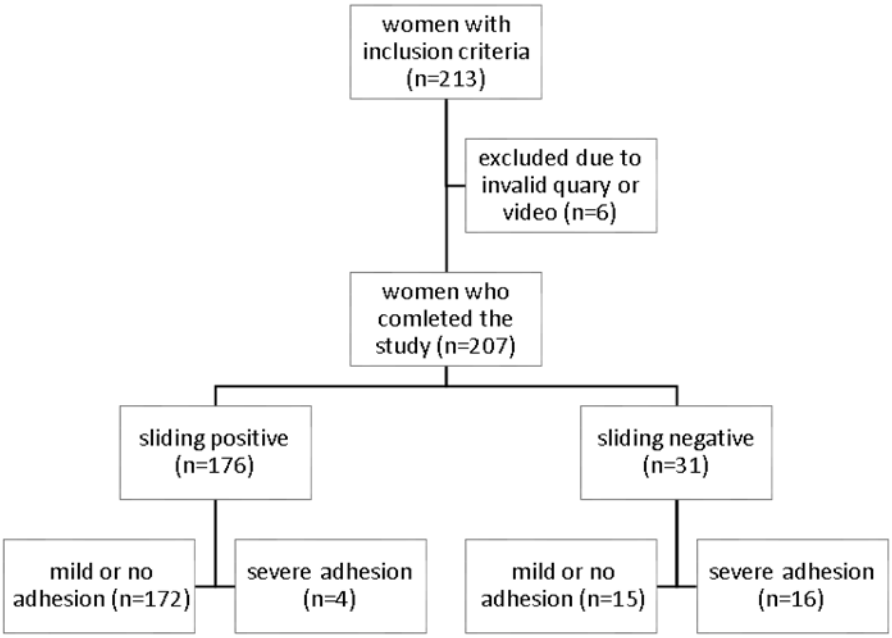

Figure 2 schematic views of women who included in the study

4. DISCUSSION

In this study is showed sliding sign by abdominal ultrasound could be a useful diagnostic tool in predicting intra-abdominal adhesions, especially in severe cases in mothers with repeated CS. The prevalence of adhesions in cases of repeated CS was 17.9% totally (first degree 8.2%, second 1.9% and third 7%). In Yaghmae et al.'s study, the prevalence of adhesion following CS was 32% and the prevalence of severe adhesion and frozen pelvis was 15.6%, which was higher than our estimation (Yaghmaei, 2018). Tulandi found a prevalence of adhesions in second CS 24.4% and in third CS 42.8% (Tulandi, 2009). Hesselman noted the number of CS was the important predictor of adhesions: 32% after once; 42% after twice and 59% after three or more (P < 0.001) (Hesselman, 2018). This lower incidence in our study may be due to the different cesarean technique (ten Broek, 2013) and type of used suture thread. For example, in recent years, Vikryl has been used more in Iran than chromic cutgut.

In our study, not only the number of previous CS was higher in the adhesion group (1.78 vs. 1.37-P = 0.0001) but also significantly fewer cesarean sections were found in the negative sliding sign group (1.40 vs. 1.71; P = 0.026). Awonuga showed the rate of adhesion increases with the frequency of CS (Awonuga, 2011). We also observed this finding in another statistical expression. In this study, in mothers with repeated CS and intraoperative adhesion abdominal surgery was seen in two cases and pelvic surgery in three cases. One case of severe adhesions had a history of abdominal surgery (appendectomy) and two cases of severe adhesions had a pelvic surgery (myomectomy and salpingectomy). Awonuga stated the adhesions following gynecological operations occur more often on the posterior uterus, while adhesions following CS are more common in the anterior Cul-de-sac and suggested patients with repeat cesarean delivery may develop fewer adhesions (Awonuga and Fletcher, 2011). According to Lower study in 2000, operations on the ovary were associated with greater adhesion among gynecological surgeries (Lower, 2000). In this study, no significant relationship was found between the location of adhesion and severity of adhesion, possibly due to the small number of surgical history. For example, we did not have surgery on the ovary.

In our study, there was a statistically significant difference in the duration of surgery. Incision time in the adhesion group was 8 minutes and in the non-adhesion group 4 minutes. Similarly delivery time in the adhesion and non-adhesion groups was 11 and 6.5 minutes, respectively. In addition, as the intensity of adhesion increased, the times became longer. Shenhav in 2019 found that pregnant women with repeated CS with adhesion had a longer incision to delivery time (10.3 ± 5.9 versus 8.2 ± 3.7 minutes, respectively; p = 0.04). In the severe adhesion group (grade 3), the mean delivery time was longer than the without adhesion group and the difference was statistically significant (13.0 versus 8.2 minutes; p = 0.002). The results of this study were consistent with our study (Shenhav, 2019). In Greenberg's study, 92 patients with first repeated cesarean and adhesions, delivery time in dens adhesions (score greater than 3) were 19.8 min, compared to 15.6 min with scores equal or less than 3 (p=0.04). Although the delivery time was longer than our estimation, it was increased in severe adhesions compared to the mild adhesions (Greenberg, 2011), which was consistent with our study. Tulandi in the 2011 showed the incision–delivery interval and the operating time were higher at repeated CS than primary cesarean section. A correlation was found between the adhesion score and the incision-delivery interval (r = 0.23, P < 0.0001) and duration of the surgery (r = 0.26, P < 0.0001) (Tulandi and Al-Sannan, 2011).

In this study, we found that first-minute Apgar score decreases with increasing adhesion intensity, with the lowest 1-minute Apgar score in grade 3 adhesion. In 2006, Morales noted babies born with elective repeated CS were more likely to have a cord PH <7.2 than infants born with primary cesarean section (OR, 2.3; 95% CI, 1.1-4.5; P= .017). The 1-minute Apgar score also correlated with delivery time. 1-minute Apgar score of Infants who were delivered by elective repeated CS mas lower than infants who were delivered by elective primary cases (median, 8; interquartile range, 7-9; vs median, 8; interquartile range, 8-9; P=.005) (Morales, 2007). The results of our study are comparable to Morales's. The reduction of the first minute Apgar score is justified by the increase in the duration of the operation, which is spent on releasing the adhesions and finding the appropriate plane, and possibly maternal hypotension due to regional anesthesia.

In this study we did find no difference in transfusion requirement in the adhesion and non-adhesion group. In 2004, Rashid performed a case-control study on 308 pregnant women who had undergone four or more previous caesarean sections, He found that the incidence of blood transfusion was similar in the two groups (44% vs. 30%; p=0.30). But the hemoglobin drop level was greater in the study group compared with the control group (Rashid, 2004). In our study, the study population had less previous CS (1-4 CS) and the placenta accreta spectrum was omitted. Rouse showed the risk of packed cell transfusion is 3.2% for primary and 2.2% for previous cesarean. Although they revealed multiple factors that are associated with an increased risk of transfusion (Rouse, 2006). Although the methods of the two studies differ, the common point is that adhesion solely does not increase the transfusion requirement.

In this study, negative sliding sign had 68% sensitivity and 96.5% specificity for adhesion detection. The positive and negative predictive values of the test were 81% and 91%, respectively. Given that in the cases of severe adhesion, the sensitivity was higher and reached 80% and specificity was 92%. The positive predictive value (PPV) was52% and the negative predictive value (NPV) 98%. In Baron's study, 59 pregnant women with aprevious CS were assessed for sliding sign in third trimester. The sensitivity of the test was 76.2%, the specificity 92.1%, positive and negative predictive values 84.2% and 87/5%, respectively (Baron, 2018). The ultrasound technique in our study was quite similar to the Baron study, but parity was less in our study population (4.1±2.4 vs.1.5±0.8). The sensitivity and specificity values obtained in this study were consistent with Baron's research in predicting severe adhesion. In the study of Drukker, 370 pregnant women with repeated CS were included in the study. Sliding sign sensitivity was 56% (95% CI 35–76), specificity 95% (95% CI 93 – 97), a positive likelihood ratio of 12.1 (95% CI 6.7–21.8), and a negative likelihood ratio of 0.46 (95% CI 0.30–0.72) for severe adhesion detection. They conclude this is a simple evaluation method for patients with adhesion that was increased the accuracy by adding a history of adhesion (Drukker, 2018). Compared to our study, Drukker achieved less test sensitivity. Perhaps one reason was the higher prevalence of grade 3 adhesion in our study population (7.7% vs 3.2%).

This diagnostic procedure for suspected adhesion prior to CS is both easy and accessible in a hospital setting. It is easy to make the diagnosis within minutes with high accuracy and make the necessary arrangements for a safe caesarean section. Therefore, when CS is performed in optimum condition and preparation, it is associated with minimal complications for the mother and fetus. This diagnostic method is also convenient for the patient and is easy for trainee to learn. The strengths of this study were the appropriate sample size, ultrasound performed by one sonographer, CS by three surgeons who were trained in determining the type of adhesion prior to the start of the study, and double-blinding the sonographers and surgeons.

Limitations of this study

Loss of potential adhesion due to emergency CS or CS else where

Ultrasound is currently a qualitative method for examining adhesion and is not quantitatively capable of separating the degree of adhesion.

In obesity and multifetal pregnancy, despite repeating the test, failure to detect the positive sliding sign (false positive) was greater. Although, the highest BMI was 38.9 in our study, we propose a study in patients with high BMI and transvaginal ultrasound and comparison of abdominal and vaginal ultrasound in adhesion prediction.

Although this ultrasound examination was performed by a specialist and did not require inter-observer agreement, the intra-observer agreement was not studied.

We recommend determination of appropriate gestational age for adhesion detection in future studies.

5. CONCLUSION

Our study presented the acceptable accuracy of an easy option in detecting intra-abdominal adhesion in pregnant women with a history of previous CS. Since adhesion during CS are associated with maternal and neonatal complications, preoperative awareness helps to apply the appropriate method and make the necessary preparations before surgery. We recommend that high risk pregnant women, such as repeated CS more than once, be evaluated for intra-abdominal adhesion by sliding sign due to intra-operative complications.

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Authors' contributions

Shirin Nirumanesh:	conception and design of study, revising the manuscript critically for important intellectual content
Taraneh Arbabzadeh:	conception and design of study, acquisition of data, drafting the manuscript
Fatemeh Golshahi:	acquisition of data, revising the manuscript critically for important intellectual content
Maryam Moshfeghi:	acquisition of data, drafting the manuscript
Mahboobeh Shirazi:	acquisition of data, revising the manuscript critically for important intellectual content
Mamak Shariat:	analysis and interpretation of data

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Conflict of interest

No potential conflict of interest was reported by the authors.

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

Ethical approval

The study was approved by the Medical Ethics Committee of Tehran University of Medical Science (ethical approval code: IR.TUMS.MEDICINE.REC.1398.490).

Peer-review
External peer-review was done through double-blind method.

Data and materials availability
All data associated with this study are present in the paper and/or the Supplementary Materials.

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