The value of sliding sign in evaluation of intra-abdominal adhesions in pregnant women undergoing elective cesarean section

Doaa Shafie Belal[1]* MD, Mohamed Ismaeil Albokl[2] MD, Ahmed Shaaban Sayed Hassan[3]MBBCh, Nada Kamal[4] MD.
[1] Assistant Professor Ob & Gyn, Cairo University.
[2] Professor Ob & Gyn, Cairo University.
[3] Assistant Lecturer Ob & Gyn, Cairo University.
[4] Lecturer Ob & Gyn, Cairo University.

Abstract

Background: Incident of adhesions is a common and serious post-operative complication. Pre-operative prediction of adhesions is essential to help the surgical team in better counseling and preparation. Yet, the pre-operative assessment of adhesions is lacking. The sonographic sliding movement gives a reflection of the free mobility of the underlying viscera, hence; can predict the presence or absence of adhesions.

Objective: To study the accuracy of U/S sliding sign in pre-operative prediction of adhesions, in pregnant patients prior to CS procedure in general, and to re-adjust this data among different BMI classes in particular.

Methodology: A prospective, double-blinded study that included 235 pregnant patients at term, who were candidates for elective CS at Kasr Al-Ainy Hospital, Cairo University. We documented the type of previous surgery done. A single sonographer recorded the sliding sign pre-operatively. The surgeons reported the degree of adhesions quantitatively, according to a scoring system. Moreover, we documented the operative delivery time (time from skin incision to time of fetal delivery), and the incidence of visceral injury. Data was further re-analyzed in reference to each BMI class individually.

Results: : A total number of 235 pregnant women were recruited, with a mean age; 30 years, and mean BMI; 29kg/m2. The prevalence of adhesions was 48.51% (19.15% mild, and 29.36% marked adhesions). 0.85% of the cases had visceral injury. The prevalence of adhesions increased with the increase in number of previous CS; 22.8%, 34.2%, and 43% in cases with previous one, two, three or more CS respectively. 68.51% (n=161) of the recruited patients had positive sliding sign, while 31.49 % (n=74) had negative sliding sign. Positive sliding sign correctly identified 152 out of 166 patients who had no or mild adhesions, while negative sliding sign correctly identified 60 out of 66 patients who had marked adhesions. Accordingly, the sensitivity, specificity, PPV, NPV and accuracy of sliding sign in predicting intra-operative

Corresponding author:
Dr. Doaa Shafie Belal, MD.
E-mail: doaash@live.com
Phone number: 01099404983
Address: Department of Obstetrics and Gynecology, Cairo University, Alsaraya Street, Kasr Al Ainy, Cairo, Egypt.
Postcode: 11562

adhesions were 86.96%, 94.41%, 81.08%, 94.41% and 90.21% respectively. We further re-analyzed the data in relation to different BMI classes. The sensitivity, specificity, PPV, NPV, and accuracy specific to each BMI group were; 94.12%, 96.08%, 88.89%, 98%, 95.59% respectively in the normal weight group (n=68); 90%, 93.62%, 85.71%, 95.65%, 92.54% respectively in overweight cases (n=67); and finally, 81.25%, 86.76%, 74.29%, 90.77%, 85% respectively in the obese group (n=100). The median operative delivery time was significantly longer in patients with negative sliding sign compared to those with positive sliding sign (18.9 minutes versus 11 minutes).

Conclusion: The pre-operative assessment of the sliding sign is useful in the prediction of intra-abdominal adhesions, prior to CS procedure, especially in normal weight and overweight cases. The negative sliding sign correlates with longer operative delivery time.

Keywords: adhesions, sliding sign, cesarean section, body mass index.

Introduction

In nowadays practice, cesarean section (CS) is the most commonly surgical procedure done by obstetricians (1), and its rate is dramatically increasing worldwide (2).

On the other hand, the incident of intra-abdominal adhesions is a well-known complication that may occur following CS, with a documented incidence ranging from 24% to 58.5% in literature (3,4), and rising in a linear fashion with the increased number of previous CS (5).

These adhesions subject the patients to the risks of; difficult and lengthy repeat procedure, more blood loss, infection, visceral injury, and even hysterectomy (5). Secondary to prolonged operative time, the fetus as well is set at risk of perinatal complications (6). Long term sequale has been noted, in form of; infertility, ectopic pregnancies, and chronic pelvic pain (1,7,8). Thus, it is very helpful indeed, to detect the cases susceptible of adhesions preoperatively. This will guide the practitioners in proper patient's counseling regarding the possible risks, and proper preoperative preparation in terms of the availability of cross-matched blood, the operative setting, the anaesthetic staff awareness, the need for call of senior consultants and/or multidisciplinary team (9-13). All these precautions will eventually eliminate the maternal and neonatal morbidity in high risk cases.

Currently, surgeons lack the presence of a reliable assessment tool for the preoperative diagnosis of adhesions in cases with prior CS (14). The ultrasound (U/S) sliding sign has been suggested by some researchers to have a high predictive value in the detection of adhesions in cases with endometriosis, and chronic pelvic inflammation (9,15). More recently, the U/S sliding sign was proven to be both accurate and reproducible in such cases (16).

So, our aim was to investigate the proposed hypothesis regarding the accuracy of the U/S sliding sign in the preoperative prediction and assessment of adhesions in cases with prior pelvic surgeries, and to re-adjust the proposed accuracy in set of different BMI categories.

Materials and Methods

This is a prospective observational study, held at Obstetrics and Gynecology department, Kasr El-Aini Hospital, Cairo University, during the time interval from March 2021 till July 2021, after receiving the approval from our local ethical committee.

A total number of 235 cases were enrolled in the study, having term pregnancy (as evident by reliable dating from the first date of last menstrual period, or first trimesteric U/S), candidate for elective CS, and with a history of a previous open pelvi-abdominal surgery (CS, myomectomy, oopherectomy, salpingectomy, appendectomy, ovarian

cystectomy). Cases in need of immediate termination of pregnancy or emergency CS (as for cases with antepartum hemorrhage, fetal distress, prolapsed pulsating cord, obstructed labor), and cases diagnosed as having abnormally invasive placenta were initially excluded from the study.

All enrolled cases were subject to full history taking, and clinical examination to ensure fulfillment of inclusion criteria, and to receive informed consent.

BMI (weight in kg/ height in m2) was recorded for each patient, and accordingly the cases were further subdivided into three groups: group A (normal, BMI; 18- 24.9), group B (overweight, BMI; 25- 29.9), and group C (obese, BMI; ≥30), in reference to the WHO classification of BMI (17).

Pre-operatively, transabdominal ultrasound (TAS) - Medison U/S machine with frequency 2-6 MHz curvilinear abdominal probe - was done by a single sonographer, to ensure fetal viability, gestational age, and placental location. Using the real time TAS, pelvic sliding sign (relative motion between the maternal abdominal and uterine wall) was documented, as formerly described by Drukker et al (13).

To ensure uniform technique, all cases were set in supine position, asked not to empty the bladder, and instructed to breathe deeply, accentuating their respiratory movements while the sonographer was recording a video clip in sagittal plane, so as to determine freely glided movement of a certain structure in relation to adjacent structures.

Noting structures that glide easily, one against the other was considered as positive sliding sign ,whereas, no motion of the structure was considered a negative sliding sign. For being more precise, stable echogenic visceral point (the uterus) was marked as point A, the patient was asked to take a deep inspiration and exhalation while the sonographer recorded a clip, the movement of point A was observed, and the new area was marked as point B. The visceral slide was destined to be the longitudinal distance between point A and point B. A positive sliding sign was recorded if the anterior uterine wall was seen sliding across the abdominal wall more than one cm and a negative sliding sign with no evidence of such relative motion, as formerly described by Baron et al (11).

CS was done within 24 hours from the TAS examination, a detailed description of adhesions was provided through direct observation by the surgeons. Intra-operative adhesions encountered were graded according to the severity using a standardized scoring system; proposed by Bolnick et al (18) in literature. (0: no adhesions, 1: minimal or filmy adhesions, 2: moderate or thick adhesions, 3: absence of free space between the uterus and the anterior abdominal wall).

Other intra-operative recorded data included; the duration of the intervention (from skin incision to delivery of the baby) expressed in minutes, and the occurrence of bladder and bowel injury.

To avoid inter-observer bias, and to interpret the data objectively; the sonographer was blinded to the type of previous surgery the patient had. For the same reason, the operating surgeons were blinded as well to the TAS sliding sign result.

Our primary concern was to assess the accuracy of the U/S sliding sign in diagnosing the presence and the degree of severity of intra-abdominal adhesions. Other secondary outcomes included; re-adjustment of the accuracy of sliding sign in prediction of intra-abdominal adhesions in relation to the patient's BMI category, the operative time (skin incision time to delivery time), and visceral (bladder or bowel) injury.

Statistical Analysis

Sample size calculation was based on the sensitivity of sliding sign detected by ultrasound scan done to full term pregnant

women in predicting the presence of intra-abdominal adhesion after prior CS. Prior data indicated that the sensitivity of the sliding sign in predicting intra-abdominal adhesion after CS ranged from 56% to 76.2%, with an average of 66.1%. If the prevalence of intra- abdominal adhesions after CS is 38% (19), According to the sensitivity estimation formula with 95% confidence 80% power setting type I error probability to 0.05. We needed to study at least 225 third trimester pregnant women to be able to reject the null hypothesis. Calculations were done using Flahault et al equation (20).

Data were coded and entered using the Microsoft excel version 2013. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between groups were done using unpaired t test in normally distributed quantitative variables while non-parametric Mann-Whitney test was used for non-normally distributed quantitative variables. For comparing categorical data, Chi square ($\chi 2$) test was performed. Exact test was used instead when the expected frequency is less than 5. P-values less than 0.05 were considered as statistically significant.

Results

We examined a total number of 235 pregnant women, at term (completed 37weeks gestation), who were candidates for elective CS, from March 2021 to July 2021.

The age, BMI, and gestational age in terms of mean ± standard deviation (SD) were; 30 ± 5.53 years, 29 ± 5 kg/m2, and 38 ± 0.87 weeks respectively. All cases were multiparas, in whom 114 cases (48.51%) were noted to have intra-abdominal adhesions; as evident by the operative findings.

In review of the past medical history; 32 cases (13.62%) had medical disorders, in form of hypertension, diabetes mellitus, cardiac disease, anemia, and epilepsy. As for the history of previous operations; 217 cases had previous CS, 15 cases had appendectomy, and 3 cases had open myomectomy. (Figure 1)

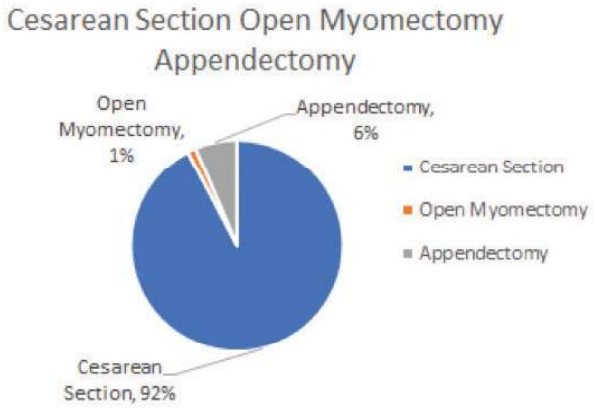

Figure (1): The number of previous pelvi-abdominal surgeries among the study group

In those with history of previous CS, we reported the incidence of adhesions in relevance to the number of previous CS. The intra-abdominal adhesions were encountered in; 22.81% (n= 26), 34.21% (n= 39), and 42.98% (n= 49) in cases with previous 1 CS, previous 2 CS, and previous ≥ 3 CS respectively.

The results of TAS sliding sign were documented separately from those noted intra-operatively (the presence & degree of adhesions, operative time, and visceral injury).

161 cases elicited a positive sliding sign, in whom, 117 cases (72.67%) had no adhesions, while; 35 cases (21.73%), and 9 cases (5.59%) & had mild & marked adhesions respectively. On the other hand, 74 cases had a negative sliding sign, in whom, 60 cases (81.08%) had marked adhesions, while; 10 cases (13.51%) and 4 cases (5.4%) had mild and no adhesions respectively (Figure 2). A statistically significant difference (P value <0.001) was noted between both groups; cases with positive and negative sliding sign in prediction of adhesions. The positive

sliding sign predicted absence of adhesions, whilst, the negative sliding sign was in favor of presence of marked adhesions.

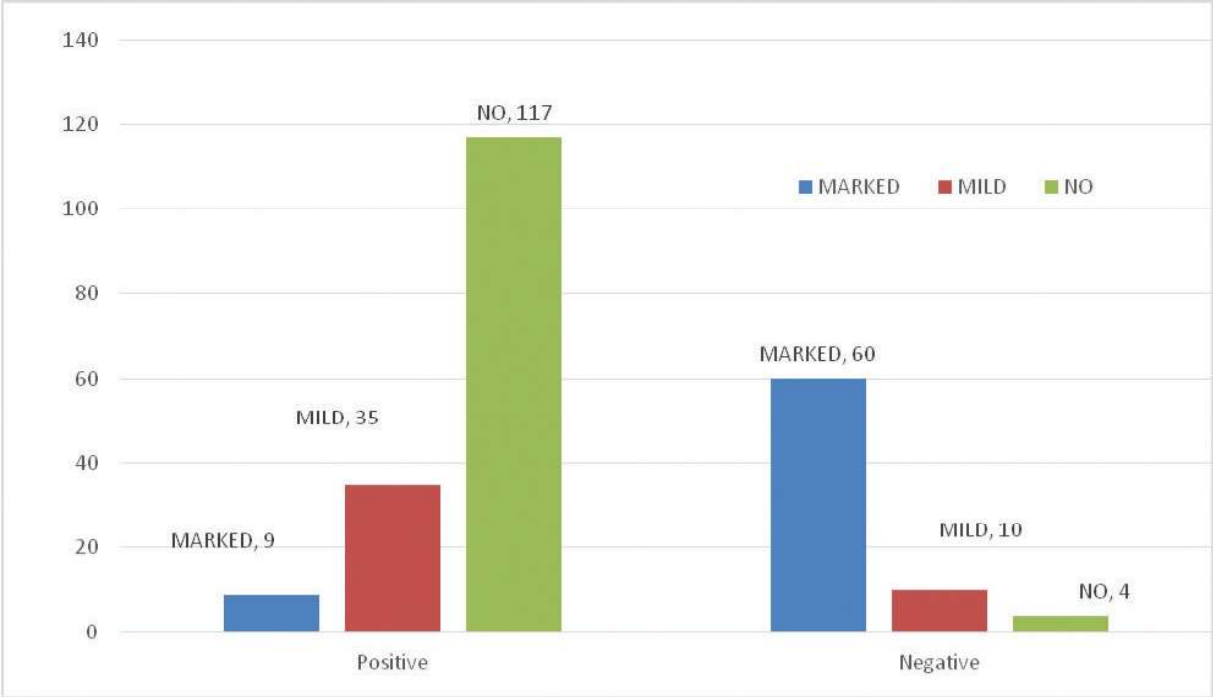

Figure (2) : Association between sliding sign and adhesions.

We considered cases with mild adhesions & those with no adhesions to be set in the same categorical class. Thereafter, the association between the U/S sliding sign and adhesions noted intra-operatively are summarized in Table (1). Accordingly, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of the diagnostic performance of the sliding sign in predicting intra-operative abdominal adhesions, were; 86.96%, 91.57%, 81.08%, 94.41%, and 90.21% respectively.

Table (1): Comparison between positive & negative sliding signs and the operative adhesions

Sliding sign	no or mild adhesions	marked adhesions	Total	p-value*
Positive	**152**	**9**	**161**	**<0.001**
Negative	**14**	**60**	**74**	
Total	**166**	**69**	**235**	

*chi square test

Further classification of the cases according to their BMI, highlighted the different predictive value of the sliding sign in each group individually (Table 2). In the normal weight group (n= 68); 50 cases had positive sliding sign (1,13,36 cases with marked, mild, and no adhesions respectively), while 18 cases had negative sliding sign (16,2,0 cases with marked, mild, and no adhesions respectively). In the overweight group (n= 67); 46 cases had positive sliding sign (2,4,40 cases with marked, mild, and no adhesions respectively), while 21 cases had negative sliding sign (18,2,1 case with marked, mild, and no adhesions respectively). In the obese group (n= 100); 65 cases had positive sliding sign (6,18,41 cases with marked, mild, and no adhesions), while 35 cases had a negative sliding sign (26,6,3,cases with marked, mild, and no adhesions).

Table (2): Comparison between positive & negative sliding signs and adhesions at different BMI categories.

	Normal weight group		
Sliding	MARKED	MILD	NO
Sign	Adhesions	Adhesions	Adhesions
Positive	**1 (2%)**	**13 (26%)**	**36 (72%)**
Negative	**16 (88.89%)**	**2 (11.11%)**	**0 (0%)**
Total	**17**	**15**	**36**
P value	**<0.001**		
	Overweight group		
Sliding	MARKED	MILD	NO
Sign	Adhesions	Adhesions	Adhesions
Positive	**2 (4.35%)**	**4 (8.7%)**	**40 (86.96%)**
Negative	**85.71 (2%)**	**2 (9.52%)**	**1 (4.76%)**
Total	**20**	**6**	**41**
P value	**<0.001**		
	Obese group		
Sliding	MARKED	MILD	NO
Sign	Adhesions	Adhesions	Adhesions
Positive	**6 (9.23%)**	**18 (27.69%)**	**41 (63.08%)**
Negative	**26 (74.29%)**	**6 (17.14%)**	**3 (8.57%)**
Total	**32**	**24**	**44**
P value	**<0.001**		

Similarly, we considered cases with mild adhesions & those with no adhesions to be set in the same categorical class, and re-analyzed the data in reference to their BMI category. Accordingly, the sensitivity, specificity, PPV, NPV and accuracy of the diagnostic performance of the sliding sign in predicting intra-operative abdominal adhesions, were; 94.12%, 96.08%, 88.89%, 98.00% and 95.59% respectively in the normal BMI group, and 90.00%, 93.62%, 85.71%, 95.65% and 92.54% respectively in the overweight group, and 81.25%, 86.76%, 74.29%, 90.77% and 85.00% respectively in the obese group.

As a secondary outcome, the operative delivery time, defined as the time elapsed from skin incision to the delivery of the baby, was assessed (in minutes). It was significantly longer (p value < 0.001) in cases with negative sliding sign (median, range; 18.3, 16-21) compared to those with positive sliding sign (median, range; 11.6, 9-14).

In relation to the presence and degree of adhesions, the operative delivery time was significantly longer in cases with marked adhesions (19.8± 2.9), compared to those with mild adhesions (11.7± 2.6), or no adhesions (11± 3.2).

To sum up the outcome of the study participants, 161(68.51%) cases elicited a positive sliding sign, while 74 (31.49%) cases had a negative sliding sign. No adhesions were encountered in 121 cases (51.49%), whilst 45 cases (19.15%) had mild adhesions, and 69 cases (29.36%) had marked adhesions. The incidence of visceral (bladder/bowel) injury was 0.85% (n= 2).

Discussion

Occurrence of adhesions is a common post-operative complication (2). In face of increasing rates of CS worldwide, the prevalence of adhesions in turn is relatively high (3,4), and rising in a linear fashion with the increased number of previous CS (5,21). The prevalence of adhesions in our study group was 48.51% (19.15% mild and 29.36% marked adhesions). The incidence of adhesions increased with higher number of previous CS; 22.8% , 34.2% and 43% in cases with previous one, two, three or more CS respectively.

Several strategies have been proposed to predict the presence of adhesions, as; previous surgical history, characters of striae gravidarum, and skin scar evaluation (14,22,23). However, these attempts lack reproducibility, and unreliable history taking is usually the case in many situations.

Sigel et al (24), proposed the U/S sliding test to detect intra-abdominal adhesions as an attempt to avoid bowel injury. It has been reported that; the sliding movement of the viscera underneath the abdominal wall, elicited by deep inhalation, can be observed by U/S. The absence of this movement-negative sliding sign- can be used as a useful marker for the presence of intra-abdominal adhesions.

So, the aim of our study was to investigate the value of U/S sliding sign in the prediction of intra-abdominal adhesions in cases with prior pelvic surgeries.

Formerly, some sonographic signs were viewed as features suggestive of adhesions, as; the adherence of the CS scar to the anterior abdominal wall, lack of CS scar mobility when the uterus was pushed with the examining probe, elongated pulled up cervix, non-visualization of the full bladder between the uterine fundus and anterior abdominal wall, retroverted uterus forming an angle with the distended urinary bladder (10,25).

More recently, dynamic U/S assessment has been used to evaluate the possibility of adhesions before laparoscopic procedures (26). A systematic review conducted by Limperg et al (27), reviewing 25 articles that included 1609 patients, concluded that the U/S visceral slide has a high NPV for the absence of adhesions. This review was concerned about the risk of bowel adhesions, and safe laparoscopic entry, thus the area around the umbilicus was the only site of interest in their research.

All the previously mentioned studies examined the prediction of adhesions on small uteri, in gynecological practice.

In obstetric practice, Baron et al (11), and Drukker et al (13) were pioneer investigators to assess the integrity of this diagnostic tool in patients with previous CS. For pre-operative prediction of intra-abdominal adhesions, the sliding sign had 76.2% sensitivity, 92.1% specificity, 84.2% PPV, 87.5% NPV, 9.64 positive likelihood ratio (LR), and 0.26 negative LR, as stated by Baron et al (11); whilst, Drukker et al(13) declared a 56% sensitivity, 95% specificity, 12.1 positive LR and 0.46 negative LR. The study conducted by Baron et al (11) was limited by the small number of recruited cases. Moreover, one third of their cases had a high BMI, which may have affected the results interrogation. On the other hand, Drukker et al (13), overcame these pitfalls in their study by recruitment of large number of cases (n=370), and excluding those with high BMI (≥40). Still, their scope of work focused on the detection of severe adhesions only, and evaluated the sliding sign at one location only, though dense adhesions were probably better detected at different sites.

In our data analysis; the positive sliding sign correctly identified 152 out of 166 patients who had no or mild adhesions, whereas, the negative sliding sign correctly identified 60 out of 66 patients who had marked adhesions. So, we reported 86.96% sensitivity, 91.57% specificity, 81.08% PPV, 94.41% NPV,

and 90.2% accuracy of the sliding sign in prediction of intra-abdominal adhesions.

Comparably, Bukar et al (28), claimed a sensitivity & a specificity 100% in each in determining the presence or absence of intra-abdominal adhesions, and further analyzed the data according to the degree of adhesions, with a sensitivity and a specificity; 65%, 82.98% respectively in cases with moderate adhesions, and 25%, 98.41% respectively in cases with severe adhesions. Still, their results should be interpreted with caution, as their sample size was relatively small (n=67), and they did not take into consideration the factors that may affect U/S accuracy (as high BMI), together with the lack of intraobserver variable analysis.

To the best of our knowledge, we are the first to assess this diagnostic modality in relation to different BMI categories. The sensitivity, specificity, PPV, NPV, and accuracy specific to each BMI group were; 94.12%, 96.08%, 88.89%, 98%, 95.59% respectively in the normal weight group (n=68); 90%, 93.62%, 85.71%, 95.65%, 92.54% respectively in overweight cases (n=67); and finally, 81.25%, 86.76%, 74.29%, 90.77%, 85% respectively in the obese group (n=100). The diagnostic performance of U/S sliding sign in prediction of intra-abdominal adhesions is comparable in the normal weight and overweight classes, but relatively decreases in obese cases. This comes in agreement with the fact that U/S accuracy is highly correlated with the abdominal wall thickness (13,29).

On the contrary, Shu W(12) in examining the sliding sign in 112 Asian women claimed that it has modest ability in the detection of dense uterine-abdominal adhesions, with 53.3% sensitivity. Still, this study described the adhesions qualitatively, though the quantification of post CS adhesions is feasible, and was recommended by Shu W herself to be adopted by clinicians and investigators (30,31).

In assessment of secondary outcome parameters, Bukar et al, documented the duration of establishing the sliding sign by sonographers (mean ± SD; 7.56 ± 2.86 seconds), to highlight its feasibility in the preoperative preparation, being not time consuming, but they did not report the operative time (28).

We documented the operative delivery time in all cases, and correlated it with the sliding sign results as an independent factor. The operative time was significantly longer in patients with negative sliding sign compared to those with positive sliding sign (18.9min versus 11min). This may highlight the added value of the sliding sign in prediction of the state of difficulty of the surgical procedure irrelevant to the presence or absence of adhesions. Similarly, it has been stated in literature that cases susceptible of adhesions will exhibit a longer operative time (5,31,32). These data may help the surgical team when known prior to the procedure done.

There are several aspects of strength in our study; its prospective nature and double-blinded study design, only one expertise in U/S was assigned to the role of U/S sliding sign documentation, the quantitative assessment of intra-abdominal adhesions in terms of scoring, the relatively large number of our study population in comparison to other researches, and finally, the further analysis of the sliding sign accuracy in relation to different BMI classes.

On the contrary, we have to admit that there have been some limitations. The lack of reporting the blood loss and the fetal outcome may have provided us with more added values for the sliding sign evaluation. We preferred to focus on the accuracy in relation to adhesions, and secondarily assessed the operative delivery time and re-analyzed the data in reference to BMI classes. The inter- and intra- observer variability among surgeons in reporting the degree of adhesions is another limitation. But from our point of view, this will be inevitably met in

such research, being conducted by different operators. The U/S probe as it targets the midsection of the lower uterine segment wall, adhesions involving the omentum and pelvic side walls cannot be predicted. Thus, we advise to set many locations for eliciting the sliding sign to achieve a better predictive value.

In conclusion, the U/S sliding sign can be a useful tool in the preoperative prediction of intra-abdominal adhesions, especially in normal weight and overweight patients. This in turn will enhance a more comprehensive counseling, better preoperative preparation and multidisciplinary management.

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