The Value of Ultrasonographic Sliding Sign in Prediction of Intra-Abdominal Adhesions in Pregnant Women Undergoing Cesarean Section Following Abdominopelvic Surgery: A Prospective Study

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Running title

Sliding Sign for Intra-Abdominal Adhesions

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Abstract

Objective: The current evidence is inconclusive regarding the utility of sliding sign for prediction of intra-abdominal adhesion. In the present study, we assessed the diagnostic accuracy of negative sliding sign for prediction of intra-abdominal adhesion in pregnant women scheduled for Cesarean section (CS) and had a history of previous abdominopelvic surgery.

Methods: A prospective, observational, study was conducted on 158 full-term pregnant women who were candidates for elective cesarean section.

Results: A total of 16 (10.2%) women had negative sliding sign and 8.9% had marked adhesions. The positive sliding sign accurately detected 138 (95.8%) out of 144 patients with no or minor adhesions, while the negative sliding sign correctly recognized 10 (71.4%) out of 14 patients with significant adhesions during the CS treatment. The sliding sign demonstrated a sensitivity of 71.4%, specificity of 95.8%, positive predictive value (PPV) of 62.5%, and negative predictive value (NPV) of 97.1% in predicting significant intra-operative adhesions. In contrast, patients who did not exhibit a sliding sign had a higher probability of suffering from intra-operative bleeding, a significant decrease in hemoglobin levels of more than 3 g/dl, visceral injury, and a longer delivery time ($p < 0.001$).

Conclusion: In conclusion, our findings highlight that the negative sliding sign can be used for prediction of severe intra-abdominal adhesions; the negative sliding sign is an accurate, reproducible, and easily accessible method for prediction of adhesions in clinical setting. Moreover,

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patients with negative sliding sign appears to have higher risk of prolonged delivery, intra-operative bleeding, and visceral injury.

Keywords: Intra-abdominal adhesion; Cesarean section; Maternal outcomes; Sliding sing; Ultrasound.

Abbreviations

CS: Cesarean section

STROBE: STrengthening the Reporting of OBservational studies in Epidemiology

BMI: Body mass index

TAUS: Trans-abdominal ultra-sonography

Key massage

- Sliding sign can be used for prediction of intraabdominal adhesions
- The assessment is feasible during the third trimester.
- Routine assessment of sliding sing is warranted to accurately anticipate the complexity of the procedure and properly plan for it..

Introduction

Cesarean section (CS) is the most common obstetric surgery, with an increasing prevalence of the US by 50% over the last decade[1]. CS is mostly performed according to fetal indications but can also lead to some significant maternal and fetal complications[2]. Hemorrhage, hysterectomy, infection, bladder, and bowel injury are the main complications of CS[3–6]. Furthermore, intra-abdominal adhesions due to surgical duration and the perinatal adverse outcome associated with the postpone of the neonate delivery in the case of an urgent CS are among the most critical complications of CS[7,8].

Intraabdominal adhesion is an irregular bond between the anatomic structural surfaces, with a varying severity after repeated intraabdominal or pelvic procedures[9]. The implications of these kinds of abnormal associations include bowel obstruction, persistent abdominal and pelvic pain, the necessity for re-intervention, ectopic pregnancy, miscarriage, and accidental damage or failure to the organ throughout surgery [10,11].

Some investigators have suggested abdominal scar characteristics and surgical history as potential indicators for adhesion presence and severity, due to the lack of a reliable non-invasive method for preoperative identification of intraabdominal adhesions[12,13]. Nevertheless, these techniques are not reproducible, and the history of prior surgery also maybe does not exist. On the other hand, it has been shown that the sonographic sliding organ sign has high predictive power for detecting pelvic adhesions in women with chronic pelvic inflammation, endometriosis, and infra-umbilic adhesions before the laparoscopic procedure [14,15]. The idea behind this technique is to assess the relative motion between the abdominal and uterine walls by ultrasonography[15]. A negative sliding sign showed a significant role in predicting the severe intraabdominal

adhesions owing to its high specificity[16]. In this study, we aimed to investigate the predictive value of ultrasonographic sliding sign towards the intraabdominal adhesions in pregnant women undergoing CS following abdominopelvic surgery.

Materials and Methods

We prepared the present manuscript in concordance with the recommended standards of STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) statement[17]. The study's protocol was approved by local ethics committee of Kasr-Alainy University hospital.

Patients and Setting

We conducted a prospective, observational,

study at the Obstetrics & Gynecology Department, Kasr-Alainy hospital between March 2019 and September 2019. The study involved 158 pregnant women who were elected for CS. All Patients were informed about the study and were required to give verbal consent for study participation and to sign a written consent for conduction CS. The inclusion criteria targeted full-term pregnant with prior history of abdominopelvic surgery. Patients with a body mass index (BMI) of more than 40Kg/m2, abnormal placental invasions, or emergent CS were excluded.

Sample size calculation was based on the sensitivity of the sliding sign detected by ultrasound. Literature indicated that the sensitivity of the sliding sign in predicting intra-abdominal adhesion after Cesarean section ranged from 56% to 76.2%, with an average of 66.1%. Assuming that the prevalence of intra-abdominal adhesions after CS is 38%(8). These assumptions estimated a sample of 158 full-term pregnant women to detect the main effect with 80% power setting type I error rate of 5%. Calculations were done using Flahault et al's equation[18].

Data Collection and Sliding Sign Assessment:

Each participating woman was subjected to a full history taking, clinical examination, and routine laboratory investigations. The operative time, pre and postoperative hemoglobin levels, and the incidence of bladder and/or bowel injury were registered as well.

Trans-abdominal ultra-sonography (TAUS) was conducted using Samsung Ws80a systems during the preoperative examination, using the real-time TAUS pelvic sliding sign as described by Drukker et al[16]. The sonographers were blinded to the type of previous surgery to interpret objectively the TAUS sliding sign.

The patient was advised to take deep breaths, emphasizing her respiratory motions, while the sonographer recorded a video clip in a mid-sagittal plane positioned to the side of the umbilicus, focusing on the area below the umbilicus. The purpose was to assess if the structure moved smoothly in relation to nearby structures. In order to be classified as sliding, the structures needed to exhibit smooth movement of their surfaces (indicating positive sliding). Negative sliding was identified when no movement of the structures was seen[19].

Assessment of Adhesion

Patients underwent a lower segment cesarean section (CS) 24 hours following the TAS assessment. Surgeons directly observed and offered a full description of any adhesions and unintentional harm. The adhesions were classified according to a standardized grading system into: Grade 0: No adhesions were found. Grade 2: Moderate or thick adhesions were observed. Grade 3: There was no free space between the anterior

abdominal wall and the uterine wall[20]. The surgeons were blinded to the TAUS sliding sign results.

Study's Outcomes

The primary outcome of this observational prospective study was the predictive accuracy of sliding signs for intraabdominal adhesions using TAUS done to full term pregnant after CS operations. Secondary outcomes included the associations between negative sliding signs and sever intraabdominal adhesions, operative times (skin incision to delivery of the baby), hemoglobin drop, and bladder or bowel injury.

Statistical analysis of the collected data

Data were managed using the statistical package SPSS (Statistical Package for the Social Sciences) version 25. Quantitative data were summarized using mean, standard deviation, median, and range. Regarding qualitative data, frequency (count) and relative frequency (percentage) was calculated. Normally distributed continuous variables were tested using independent sample t-test. Mann-Whitney test was

performed on the continuous variables that not following the normal distribution. For comparing categorical variables, Chi-square ($\chi 2$) and Exact tests were conducted. A p value less than 0.05 was considered statistically significant (two-sided testing).

Results

The mean age of the included women was 30.6 ±4.04 years and the mean BMI was 30.9 ± 2.5 kg/m2. The average gestational age of the participants was 38.2 ± 2.3 weeks. Of the included patients, 90.5% were multi-paras. The vast majority of the women (77%) had a history of previous CS, 14% underwent appendectomy before, 6% had done open myomectomy before, and 3 % experienced previous exploratory laparotomy. The frequency of positive sliding sign was 89.2% among the recruited patients. Among the three categories of adhesion severity, 82.9% of the involved participants had no adhesions after CS procedure, while 8.9% had marked adhesions. Furthermore, 3.8% of the patients were complicated with a visceral injury. Only 2.5% of the study cohort complicated with HB drop> 3g/dl (Table 1).

Overall, the positive sliding sign was correctly identified in 138 (95.8%) out of 144 patients who had no or mild adhesions on CS procedure while negative sliding sign was correctly identified 10 out of 14 (71.4%) patients who had marked adhesions on CS procedure (Figure 1). Thus, negative sliding sign yielded a sensitivity of 71.4%, specificity of 95.8%, positive predictive value of 62.5%, and negative predictive value of 97.1% for detection of marked adhesions.

Regarding delivery time, patients with negative sliding signs recorded significantly longer delivery time than positive patients ($p < 0.001$). Also, patients with negative signs were more liable to visceral injury (25.0%) compared to patients with positive sign (25.0% vs 1.4%, $p <0.001$). According to the site of injury, the incidence of bladder injury among patients with positive sign was 1.4 % (2 out of 142) and 18.7 % (3 out of 16) among patients with negative one and incidence of intestinal injury among

patients with negative sign was 6.25% (1 out of 16), no intestinal injuries were recorded in patients with positive sign (Table 2).

Discussion

The current evidence is inconclusive regarding the utility of sliding sign for prediction of intra-abdominal adhesion. In the present study, we assessed the diagnostic accuracy of negative sliding sign for prediction of intra-abdominal adhesion in pregnant women with a history of previous abdominopelvic surgery. The negative sliding sign achieved fair diagnostic accuracy for prediction of severe intra-abdominal adhesions. In addition, patients with negative sliding sign had significantly higher incidence of prolonged delivery, intra-operative bleeding, and visceral injury.

Intraabdominal adhesion is a major concern in women undergoing CS, especially among those with a history of abdominopelvic surgery; previous reports indicated that intraabdominal adhesion significantly increased the risk of intra and postoperative complications such as bowel obstruction, excessive intraoperative hemorrhage, prolonged operative time, and accidental damage or failure to the organ throughout surgery[21–23]. Thus, it is imperative to accurately predict intra-abdominal adhesion in at-risk women; nonetheless, established predictors, such as abdominal scars, revealed low diagnostic accuracy and poor reproducibility[12,13]. Thus, recent reports suggested the use of ultrasound-based techniques as a simple, non-invasive, predictors of intra-abdominal adhesion[24]. In the present study, we demonstrated that negative sliding sign achieved fair diagnostic accuracy for prediction of severe intra-abdominal adhesions; negative sliding sign

yielded a sensitivity of 71.4%, specificity of 95.8%, positive predictive value of 62.5%, and negative predictive value of 97.1% for detection of marked adhesions.

These findings are in line with previous report by Drukker et al.[25], who showed that the negative sliding sign achieved a sensitivity and specificity of 56 and 95%, respectively, for prediction of severe adhesion in women with history of CS. In another report on 59 women, the negative sliding sign achieved sensitivity and specificity of 76.2% and 92.1%, respectively, for detection of high risk adhesions[19]. Notably, Ayachi et al.[26], reported higher diagnostic performance of sliding sign among women with previous abdominopelvic surgery, with a sensitivity and specificity of 96.3% and 92.6%, respectively. The sliding sign demonstrated good diagnostic accuracy for prediction of intraabdominal adhesion for in women undergoing other procedure than CS as well[27].

Factors, such as prolonged delivery time and excessive bleeding, adversely affect the maternal and neonatal outcomes of CS; while intraabdominal adhesion is a risk factor for prolonged delivery time, intraoperative bleeding, and visceral injury[28]. In the present study, we demonstrated that the negative sliding sign correlated significantly with prolonged delivery, intra-operative bleeding, and visceral injury. These findings were in agreement with reports by Drukker et al.[25] and Ayachi et al.[26].

Our findings have important clinical implications. Based on our findings, negative sliding sign is an accurate, reproducible, and easily accessible method for prediction of adhesions in clinical setting. The assessment is feasible during the third trimester in pregnancy and the BMI do not appear to affect its result[19]. Thus, routine assessment of sliding sing in at-risk women is warranted preoperatively. In at-risk women, surgeons can accurately anticipate the complexity of the procedure and properly plan for it. The surgeon can even refer the case to specialized, equipped, center with multidisciplinary team or experienced surgeon; especially that our results indicated the negative sliding

sign correlated significantly with intra and postoperative complications such as prolonged delivery, excessive hemorrhage, and visceral injury.

We acknowledge that the present study has some limitations. The significant association between negative sliding and intra-abdominal adhesions was not adjusted according to type of previous abdominopelvic surgery or the number of adhesions owing to the small number of patients with negative sliding sign. Another limitation is the use of surgeon-based score for grading of intra-abdominal adhesions, which may lack consistency between surgeons. We did not include morbidly obese women in our study as well; those the impact of obesity on the results of ultrasound assessment was not studied in the present report.

In conclusion, our findings highlight that the negative sliding sign can be used for prediction of severe intra-abdominal adhesions; the negative sliding sign is an accurate, cheap, easily accessible, and reproducible method for prediction of adhesions in clinical setting. Moreover, patients with negative sliding sign appears to have higher risk of prolonged delivery, intra-operative bleeding, and visceral injury. Based on the results of our study, we recommend the detection of the simple, non-invasive, sliding sign prior to elective CS in order to discriminate between high and low risk intraabdominal adhesions in patients with history of previous abdominopelvic surgery; this practice may decreases the risk of complications such as bladder, bowel injury, and hemorrhage. Nonetheless, the findings of the present study should be further investigated.

Disclosure of interests

All authors confirm no financial or personal

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Table 1: Outcomes of study participants.

Outcome	Study cohort (n = 158)
Sliding sign, n (%)	
Positive	142 (89.2)
Negative	16 (10.2)
Intraoperative adhesions, n (%)	
No	131 (82.9)
Mild	13 (8.2)
Marked	14 (8.9)
Hb drop (g/dl) , n (%)	
<1	45 (28.6)
1-2	101 (63.9)
2-3	8 (5)
>3	4 (2.2)
Visceral Injury, n (%)	
No	152 (96.2)
Yes	6 (3.8)

Table 2: the relationship between sliding sign and adhesions in the study patients.

Parameters	Positive (n= 142)	Negative (n=16)	P value
Adhesions, n (%)			
No or mild	138 (97.1)	6 (37.5)	<0.001
Marked	4(2.9)	10(62.5)	
Delivery time, Median (IQR)	8 (7 – 9)	18 (10.5 – 20)	<0.001
Hemoglobin drop, n (%)			
<1g/dl	25 (17.6)	1 (6.25)	
1-2g/dl	111 (78.2)	9 (56.25)	<0.001
2-3g/dl	6 (4.2)	2 (12.5)	
>3g/dl	0 (0.0)	4 (25.0)	
Visceral injury, n (%)			
Yes	2 (1.4)	4 (25.0)	<0.001
No	140 (98.6)	12 (75.0)	

Figure 1: percentage of adhesion