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Preoperative Sonographic Prediction Of Intra-Abdominal Adhesions In Repeat Caesarean Section Pregnancy: A Prospective Observational Study

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ABSTRACT

Objectives: The "sliding sign" technique involves observing the movement between the uterus and the abdominal wall during respiration. A positive sliding sign indicates free movement, suggesting the absence of significant adhesions, while a negative sliding sign suggests restricted movement due to adhesions. This prospective observational study aims to evaluate the accuracy of preoperative transabdominal ultrasonography using the sliding sign in predicting intra-abdominal adhesions among women undergoing repeat caesarean section at a tertiary care centre.

Methods: This prospective observational study was conducted at a tertiary care centre conducted during February 2024 – September 2024 to evaluate the efficacy of preoperative transabdominal ultrasonography in predicting intra-abdominal adhesions among women scheduled for repeat caesarean sections (CS). Demographic data, including age, body mass index (BMI), parity, smoking status, and previous CS details, were recorded. The ultrasonographic findings were compared with intraoperative assessments to determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the sliding sign in predicting intra-abdominal adhesions.

Results: The study demonstrates a significant relationship between preoperative sliding sign and multiple clinical factors, including age, BMI, previous caesarean sections, and intraoperative adhesions. The presence of dense adhesions was strongly correlated with a negative sliding sign, reinforcing its role as a potential predictor of intra-abdominal adhesions in repeat caesarean section pregnancies.

Conclusion: The transabdominal sliding sign is a valuable, non-invasive tool for predicting intra-abdominal adhesions in women undergoing repeat caesarean sections. Its application in preoperative evaluations can facilitate better surgical planning and potentially reduce the incidence of intraoperative complications.

Keywords: *Sliding Sign; Intra-abdominal Adhesions; Repeat Caesarean Section; Preoperative Sonographic Prediction; Tertiary Care Obstetrics*

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 common cause [1]. Currently Caesarean section (CS) delivery is one of the most common obstetric operations, and its rate increased from 5 to 30–32% over the past 10 years. 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]. CS is a critical surgical intervention that has significantly reduced maternal and neonatal morbidity and mortality. However, the increasing prevalence of repeat CS procedures has brought attention to associated complications, notably the formation of intra-abdominal adhesions. These adhesions, which are fibrous bands forming between abdominal tissues and organs, can complicate subsequent surgeries, leading to extended operative times, increased blood loss, and a higher risk of injury to surrounding organs. Accurate preoperative identification of such adhesions is essential for surgical planning and optimizing patient outcomes [4,5].

Recent studies have explored the use of transabdominal ultrasonography to predict intra-abdominal adhesions in women scheduled for repeat CS. The "sliding sign" technique involves observing the movement between the uterus and the abdominal wall during respiration.

A positive sliding sign indicates free movement, suggesting the absence of significant adhesions, while a negative sliding sign suggests restricted movement due to adhesions [6]. Research has demonstrated that the sliding sign has a sensitivity ranging from 53.3% to 100% and specificity between 80.4% and 100% in predicting adhesions, highlighting its potential utility in preoperative assessment [7,8]. Despite these promising findings, the sliding sign technique is not yet universally adopted in clinical practice. Variations in sensitivity and specificity across studies may be attributed to differences in ultrasound equipment, operator expertise, and patient populations. Therefore, further research is warranted to validate the efficacy of this method across diverse settings and to establish standardized protocols for its implementation.

This prospective observational study aims to evaluate the accuracy of preoperative transabdominal ultrasonography using the sliding sign in predicting intra-abdominal adhesions among women undergoing repeat CS at a tertiary care centre. By correlating sonographic findings with intraoperative observations, this research seeks to determine the reliability of the sliding sign as a non-invasive predictive tool, potentially informing surgical planning and improving patient care.

2. MATERIALS AND METHODS

Study design: This prospective observational study was conducted at a tertiary care centre to evaluate the efficacy of preoperative transabdominal ultrasonography in predicting intra-abdominal adhesions among women scheduled for repeat caesarean sections (CS).

Study setting: Department of OBG in Karpaga Vinayaga Institute of Medical Sciences and Research Centre conducted during February 2024 – September 2024.

Study population: All previous caesarean pregnant patients and patients who underwent any intra-abdominal surgeries, attending antenatal clinic in Karpaga Vinayaga Institute of Medical Sciences and Research centre.

Inclusion criteria: The study included pregnant women in their third trimester with a history of at least one previous CS. Patients who underwent any intra-abdominal surgeries

Exclusion criteria: Patient who does not have the history of previous surgery.

Demographic data, including age, body mass index (BMI), parity, smoking status, and previous CS details, were recorded.

3. ULTRASONOGRAPHIC ASSESSMENT

Preoperative transabdominal ultrasonography was performed using a 3.75 MHz curvilinear transducer. The transducer was placed midline, approximately 3 cm above the transverse skin scar or 8 cm above the superior border of the pubic symphysis in cases of midline infraumbilical scars. Patients were instructed to take deep breaths to facilitate caudal movement of the uterus. The presence or absence of the "sliding sign" the movement of the uterus against the abdominal wall—was observed over two respiratory cycles. A positive sliding sign indicated free movement, suggesting no or mild adhesions, while a negative sliding sign (absence of movement) suggested severe adhesions. Limited sliding (movement between 1 and less than 2 cm) was indicative of moderate adhesions [9-11]. The time taken to assess the sliding sign was recorded in seconds. All ultrasonographic assessments were conducted by experienced obstetricians trained in the sliding sign technique.

4. INTRAOPERATIVE EVALUATION

During the subsequent CS, surgeons, blinded to the ultrasonographic findings, assessed the presence and severity of intra-abdominal adhesions. Adhesions were classified intraoperatively as follows:

- **No/Mild Adhesions:** Thin, filmy adhesions easily separable by blunt dissection.
- **Moderate Adhesions:** Adhesions requiring sharp dissection but not involving critical structures like the bladder or bowel.
- **Severe Adhesions:** Dense adhesions complicating access to the lower uterine segment, involving organs such as the bladder or bowel, and necessitating meticulous sharp dissection.

5. STATISTICAL ANALYSIS

The ultrasonographic findings were compared with intraoperative assessments to determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the sliding sign in predicting intra-abdominal adhesions. Interobserver variability was evaluated by having two independent observers review the ultrasonographic recordings, with agreement measured using Cohen’s kappa coefficient.

6. ETHICAL CONSIDERATIONS

The study was approved by the institutional ethics committee, and informed consent was obtained from all participants.

7. RESULTS

A total of 100 patients were included in this study, categorized based on age, BMI, previous obstetric history, history of abdominopelvic surgery, intraoperative adhesions, and blood transfusion status.

Age Distribution: The majority of the participants were under 20 years old (78%), 16% of the participants were between 20-30 years old, only 6% were between 30-35 years old (Table 1).

Table 1: Demographic data of study population at baseline

Parameter	Frequency (n=100)
AGE	
< 20	78
20-30	16
30-35	6
BMI	
18.5-24.9	69
25-29.9	19
>30	12

BMI Distribution: Most participants had a BMI in the normal range (18.5-24.9), accounting for 69% of the population, 19% of participants were overweight (BMI 25-29.9) while 12% were obese (BMI >30) (Table 1).

Obstetric Score: Majority of participants had one caesarean section (CS) (79%), 12% had two CS and only 9% had no prior CS (Table 2).

Table 2: Showing the details about caesarean section (CS)

Obstetric Score	Frequency (n=100)
No CS	9
One CS	79
Two CS	12

Abdominopelvic Surgery: The most common surgery was a caesarean section (91%). Other surgeries included open myomectomy (3%), appendicectomy (5%), and exploratory laparotomy (1%) (Table 3).

Table 3: showing the details of abdominal pelvic surgery, intra operative adhesions, intraoperative blood transfusion

Parameter	Frequency (n=100)
Abdominopelvic Surgery	
Caesarean section	91
Open myomectomy	3
Appendicectomy	5
Exploratory laparotomy	1
Intra operative adhesions	
No adhesions	58
Filmy adhesions	24
Dense adhesions	18
Intra operative blood transfusion	
Yes	11
No	89

History of Abdominopelvic Surgery: Caesarean section was the most common previous surgery (91%), followed by appendicectomy (5%), open myomectomy (3%), and exploratory laparotomy (1%) (Table 3).

Intraoperative Adhesions: No adhesions were observed in 58% of cases, filmy adhesions in 24%, and dense adhesions in 18% (Table 3).

Intraoperative Blood Transfusion: Only 11% of participants required a blood transfusion and 89% did not require a transfusion (Table 3).

Sliding Sign: The sliding sign was positive in 72% of cases. It was negative in 28% of cases (Figure 1).

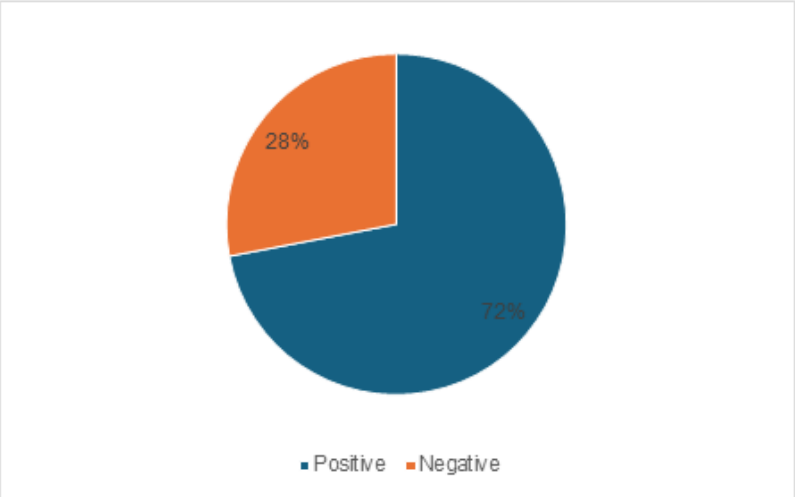

Figure 1: Pie diagram showing the details of sliding sign status in the study population

8. INFERENTIAL ANALYSIS

Association Between Age and Sliding Sign: A chi-square test was performed to determine the relationship between age and sliding sign positivity. Participants under 20 years old had a higher percentage of positive sliding signs (58 out of 78, 74.36%). The test revealed a statistically significant association ($\chi^2 = 10.01$, $p = 0.007$), suggesting that younger patients were more likely to have a positive sliding sign. The percentage of positive sliding signs decreased with age, with only 1 out of 6 (16.67%) in the 30-35 age group (Table 4).

Table 4: Relation of study parameters with sliding sign

Parameter	Positive	%	Negative	%	Total	Chi sq	p
AGE							
< 20	58	80.6	20	71.4	78	10.01	0.007
20-30	13	18.1	3	10.7	16		
30-35	1	1.4	5	17.9	6		
BMI							
18.5-24.9	52	72.2	17	60.7	69	6.32	0.04
25-29.9	15	20.8	4	14.3	19		
>30	5	6.9	7	25.0	12		
Obstetric Score							
No	5	6.9	4	14.3	9	12.46	0.002
One CS	63	87.5	16	57.1	79		
Two CS	4	5.6	8	28.6	12		
Abdominopelvic Surgery							
Caesarean section	67	93.1	24	85.7	91	3.09	0.4
Open myomectomy	1	1.4	2	7.1	3		
Appendicectomy	3	4.2	2	7.1	5		
Exploratory laparotomy	1	1.4	0	0.0	1		

Relationship Between BMI and Sliding Sign: There was a significant association between BMI and the sliding sign ($\chi^2 = 6.32$, $p = 0.04$). Participants with a normal BMI (18.5-24.9) had a higher percentage of positive sliding signs (52 out of 69, 75.36%). The percentage of positive sliding signs was lower in obese participants (5 out of 12, 41.67%) (Table 4).

Obstetric Score and Sliding Sign: A significant association was found between obstetric score and the sliding sign (χ^2 = 12.46, p = 0.002). Participants with one CS had a higher percentage of positive sliding signs (63 out of 79, 79.75%) and those with two CS had a lower percentage of positive sliding signs (4 out of 12, 33.33%) (Table 4).

Abdominopelvic Surgery and Sliding Sign: No significant association was found between the type of abdominopelvic surgery and the sliding sign (χ^2 = 3.09, p = 0.4). The majority of participants who had a caesarean section had a positive sliding sign (67 out of 91, 73.63%) (Table 4).

Correlation Between Adhesions and Sliding Sign: There was a highly significant association between intraoperative adhesions and the sliding sign (χ^2 = 63.97, p < 0.0001). Patients with no adhesions had the highest sliding sign positivity (77.8%), followed by those with filmy adhesions (22.2%). None of the patients with dense adhesions had a positive sliding sign (Table 4).

Intraoperative Blood Transfusion and Sliding Sign: A significant association was found between intraoperative blood transfusion and the sliding sign (χ^2 = 12.27, p = 0.002). Participants who did not require a blood transfusion had a higher percentage of positive sliding signs (69 out of 89, 77.53%). Those who required a transfusion had a lower percentage of positive sliding signs (3 out of 11, 27.27%) (Table 4).

9. CORRELATION ANALYSIS

Intraoperative Adhesions: There was a strong positive correlation between the absence of adhesions and a positive sliding sign (correlation = 0.69, p < 0.0001) (Table 5).

Table 5: Association of intra operative adhesions and intra operative blood transfusion with sliding sign

Parameter	Positive	%	Negative	%	Total	Chi sq	p	Correlation	p
Intra operative adhesions									
No adhesions	56	77.8	2	7.1	58	63.97	0.0001	0.69	0.0001
Filmy adhesions	16	22.2	8	28.6	24				
Dense adhesions	0	0.0	18	64.3	18				
Intra operative blood transfusion									
Yes	3	4.2	8	28.6	11	12.27	0.002	-0.2	0.008
No adhesions	69	95.8	20	71.4	89				

Intraoperative Blood Transfusion: There was a weak negative correlation between the need for blood transfusion and a positive sliding sign (correlation = -0.2, p = 0.008) (Table 5).

Age, BMI, Obstetric Score, Intraoperative Adhesions, and Blood Transfusion were significantly associated with the sliding sign. Abdominopelvic Surgery did not show a significant association with the sliding sign. The absence of intraoperative adhesions was strongly correlated with a positive sliding sign, while the need for blood transfusion was weakly negatively correlated with a positive sliding sign (Table 5).

10. DISCUSSION

The increasing prevalence of repeat caesarean sections (CS) has heightened concerns regarding intra-abdominal adhesions, which can complicate subsequent surgeries and pose significant risks to both mother and child. Accurate preoperative prediction of these adhesions is crucial for surgical planning and improving patient outcomes [10]. Our study evaluated the efficacy of the transabdominal sliding sign as a non-invasive predictor of intra-abdominal adhesions in women undergoing repeat CS.

Our findings align with previous research emphasizing the utility of the sliding sign in adhesion prediction. Bukar et al. reported that the sliding sign demonstrated a sensitivity and specificity of 100% in predicting the presence of adhesions, underscoring its potential as a reliable preoperative assessment tool [11].

Similarly, Charernjiratragul et al. found that the absence of a sliding sign was significantly associated with intra-abdominal adhesions, suggesting its practical application in clinical settings [12].

However, variations in sensitivity and specificity have been noted across studies. Drukker et al. reported a sensitivity of 56% and specificity of 95% for the sliding sign in predicting severe adhesions, indicating that while the sign is highly specific, its sensitivity may be limited [13]. These discrepancies could stem from differences in study populations, ultrasound techniques, and operator experience.

11. LIMITATIONS AND FUTURE DIRECTIONS

While our study supports the use of the sliding sign as a predictive tool, certain limitations must be acknowledged. The accuracy of the sliding sign is operator-dependent, and variations in ultrasound equipment and techniques can affect results.

Additionally, the sliding sign primarily predicts adhesions between the uterus and anterior abdominal wall; adhesions involving other intra-abdominal structures may not be detected.

Future research should focus on standardizing the sliding sign assessment protocol and training to enhance reproducibility. Exploring the integration of the sliding sign with other diagnostic modalities, such as advanced imaging techniques or biochemical markers, could improve the overall accuracy of adhesion prediction.

12. CONCLUSION

The transabdominal sliding sign is a valuable, non-invasive tool for predicting intra-abdominal adhesions in women undergoing repeat caesarean sections. Its application in preoperative evaluations can facilitate better surgical planning and potentially reduce the incidence of intraoperative complications. Ongoing efforts to standardize assessment techniques and combine diagnostic approaches are essential to optimize patient care in this context. **The sliding sign is significantly** influenced by age, BMI, obstetric history, and the presence of intraoperative adhesions. The absence of adhesions is a strong predictor of a positive sliding sign, while the need for blood transfusion is associated with a negative sliding sign. These findings suggest that the sliding sign may be a useful clinical indicator in assessing pelvic adhesions and other related conditions.

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14. RESEARCH ETHICS

The study was approved by institutional ethics committee (IEC Ref. No.: KIMS/F/09/03/2024) of Karpaga Vinayaga Institute of Medical Sciences and Research Centre, Madhuranthagam, Tamil Nadu. The study was conducted by following the tenets of the declaration of Helsinki.

Informed Consent: Informed consent was obtained from all the participants included in this study.

Author contributions: Dr Jayapriya M, is the primary investigator, Dr Collapancheri Santhanalakshmi, and Dr Arunadevi are co investigators of this study. All the authors are involved with the case identification, diagnosis, data collection, review of literature, compilation of data and drafting of the manuscript. All the authors are responsible for the final approval of the manuscript.

Use of Large Language Models, AI, Machine Learning Tools: AI tools were not used in the preparation of this manuscript.

Conflict of Interest: None declared.

Research Funding: No funding was received for this project.

Data availability: Data for this study is available from the corresponding author upon reasonable request stating the purpose clearly.

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