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Original Research Article

Adhesions in repeat caesarean sections: prevalence, predictive factors, and surgical outcomes

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ABSTRACT

Background: Adhesion formation is a common sequela of repeat caesarean sections (CS), associated with increased surgical complexity and morbidity. This study aimed to identify maternal and surgical predictors of adhesion formation and to assess its intraoperative and postoperative consequences.
Methods: This cross-sectional cohort study was conducted at Sawai Mansingh Medical College, Jaipur, from June to December 2024. A total of 100 women undergoing repeat CS were included. Data on maternal demographics, surgical history, intraoperative findings, and postoperative outcomes were collected. Adhesions were graded as mild, moderate, or dense. Statistical analysis was performed using statistical package for the social sciences (SPSS) version 26, with p value <0.05 considered statistically significant.
Results: Adhesions were present in 35% of cases 15% mild, 11% moderate, and 9% dense. Significant predictors of adhesion formation included higher body mass index (BMI) (p=0.003), greater number of previous CS (p=0.0212), and higher parity. Adhesions were significantly associated with increased operative time (mean 60.56±8.46 minutes for dense adhesions), greater hemoglobin drop (1.10±0.25 g/dl versus 0.65±0.26 g/dl, p<0.001), higher rates of intraoperative blood transfusion (66.7% versus 7.7%, p<0.001), and visceral injury (44.4% versus 0%, p<0.001). Duration of hospital stay did not differ significantly between groups.
Conclusions: Adhesion formation in repeat CS is significantly associated with maternal risk factors and adversely impacts surgical outcomes. Anticipating adhesions through risk assessment and applying meticulous surgical techniques are essential to minimize complications.

Keywords: Adhesion formation, Caesarean section, Maternal risk factors, Visceral injury, Operative time, Surgical morbidity

INTRODUCTION

Cesarean section (CS) refers to a surgical method of childbirth involving incisions made through the abdominal and uterine walls of the mother. It is typically indicated when vaginal delivery may pose health risks to the mother, fetus, or both. Over the past few decades, the global rate of CS has risen sharply from approximately 7% in 1990 to over 21% in recent estimates exceeding the World Health Organization's recommended range of 10–15%.[1,2] Large-scale observational research has shown that women undergoing repeat cesarean deliveries are more likely to develop dense intra-abdominal adhesions and abnormal placental implantation. These complications contribute to surgical difficulty, delayed fetal delivery, and increased risks of injury to pelvic organs such as the bladder and bowel. Furthermore, dense adhesions and placental abnormalities are associated with serious maternal complications, including excessive bleeding, coagulopathy, need for blood transfusions, ICU admission, and in severe cases, maternal mortality.[3-6]

Adhesions are fibrous bands of tissue that form abnormally between adjacent anatomical structures, often following surgical trauma or inflammation. They are a common postoperative complication of abdominal and pelvic surgeries and may develop as a response to tissue hypoxia, where the body attempts to restore oxygenation and nutrient supply to injured areas.[7]

Intra-abdominal adhesions following CS are frequently observed during re-entry surgeries. Reported adhesion rates increase with each successive CS: 24–46% after the second, 43–75% after the third, and up to 83% after the fourth cesarean.[8] These adhesions significantly complicate subsequent surgeries, raising the risk of organ injury, hemorrhage, postoperative infection, and even hysterectomy.[9] Adhesiolysis the surgical removal of adhesions adds further complexity, increasing the likelihood of blood loss and unintentional damage to surrounding structures. Beyond intraoperative risks, adhesions are linked to long-term complications such as bowel obstruction, chronic pelvic pain, secondary infertility due to anatomical distortion or tubal obstruction, and the need for further surgical intervention.[10]

Given the rising frequency of caesarean births worldwide, identifying clinical and procedural factors that contribute to adhesion formation is essential. This study aims to evaluate the predictors of adhesion development and assess their intraoperative impact in women undergoing repeat CS.

METHODS

Study design and population

This cross-sectional cohort study of 100 pregnant women was conducted at Sawai Mansingh Medical College, Jaipur from June 2024 to December 2024. The study aimed to identify maternal and surgical predictors of adhesion formation in repeat CS and evaluate its intraoperative consequences, including visceral injury, perioperative hemoglobin decline, and operative time. Ethical approval was obtained from the Institutional Review Board (IRB) of Sawai Mansingh Medical College and attached hospitals, Jaipur.

Women who underwent repeat CS during the study period were included if they met the following criteria: aged 18-45 years, had a second or subsequent CS, and had complete medical records. Women with contraindications to CS, those who underwent emergency caesarean, or those with incomplete data were excluded.

Data collection

Data were extracted from medical records and included the following variables: maternal characteristics including age, BMI, parity, number of previous CS, comorbidities (e.g., anemia hypertension, diabetes), and previous pelviabdominnal surgeries; surgical characteristics including type of caesarean (elective/emergency), interval between caesareans, and use of adhesion barriers; intraoperative outcomes including presence and severity of adhesions (mild, moderate, dense), visceral injury, blood loss (ml), perioperative hemoglobin decline (g/dl), and operative time (minutes); and postoperative outcomes including length of hospital stay and postoperative complications.

Classification of adhesions

Adhesions were categorized as mild (minimal separation needed), moderate (significant dissection), or dense (extensive dissection required with potential for organ injury).

Statistical analysis

Data were analyzed using statistical package for the social sciences (SPSS) version 26. Descriptive statistics were used for baseline characteristics. Continuous variables were expressed as means±SD, and categorical variables as frequencies and percentages. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 100 patients were included in the study, with 35 (35%) exhibiting adhesions and 65 (65%) having no adhesions. The baseline characteristics of the study population are presented in Table 1.

The majority of patients (65%) had no adhesions, followed by mild (15%), moderate (11%), and severe (9%) adhesions (Figure 1).

Parity, BMI, and the number of previous CS were significantly associated with adhesion formation. Specifically, the incidence of adhesions was higher in women with higher BMI ($p=0.003$) and those with more than one prior CS ($p=0.0212$). Parity was also significant, with higher adhesion rates observed in multiparous women (Table 2 and Figure 2).

Adhesion severity correlated with increased operative time, higher hemoglobin drops, and a greater incidence of visceral injury. Severe adhesions were associated with the longest operative times (60.56±8.46 minutes), the highest hemoglobin drop (1.10±0.25 g/dl), and a 44.4% rate of visceral injury (Table 3).

Patients with adhesions had significantly higher blood loss (mean hemoglobin drop of 1.10±0.25 g/dl versus 0.65±0.26 g/dl, $p<0.001$) and a greater need for intraoperative blood transfusion (66.7% versus 7.7%, $p<0.001$). Additionally, the incidence of intraoperative visceral injury was significantly higher in those with adhesions (44.4% versus 0.0%, $p<0.001$). No significant differences were found in the duration of hospital stay (Table 4).

Table 1: Baseline maternal and obstetric characteristics of the study population (n=100).

Parameters	Frequency (%)
Age group (years)	
20–25	31 (31.0)
26–30	50 (50.0)
>30	19 (19.0)
Parity	
P1	66 (66.0)
P2	27 (27.0)
P3	6 (6.0)
P4	1 (1.0)
No. of previous caesarean sections	
1	75 (75.0)
2	21 (21.0)
3	4 (4.0)
Time elapsed since last caesarean (mean±SD)	4.22±2.41
BMI category (kg/m²)	
18.5–22.9	29 (29.0)
23.0–24.9	36 (36.0)
25.0–29.9	34 (34.0)
30.0–34.9	1 (1.0)
Nature of preceding caesarean	
Elective	61 (61.0)
Emergency	39 (39.0)
Post-operative complications (wound sepsis/ resuturing)	
Present	12 (12.0)
Absent	88 (88.0)
BMI category (kg/m²)	
18.5–22.9	29 (29.0)
23.0–24.9	36 (36.0)

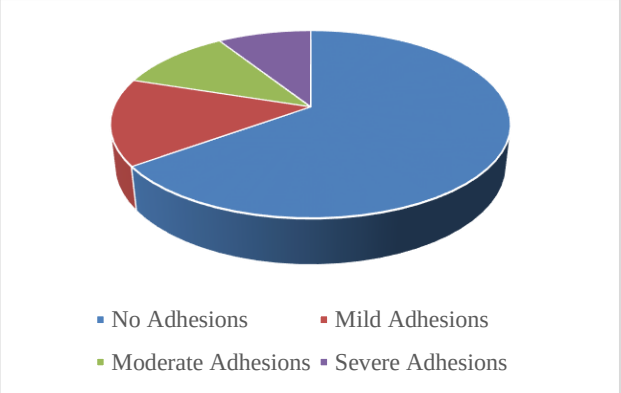

Figure 1: Distribution of adhesion grades in repeat caesarean sections.

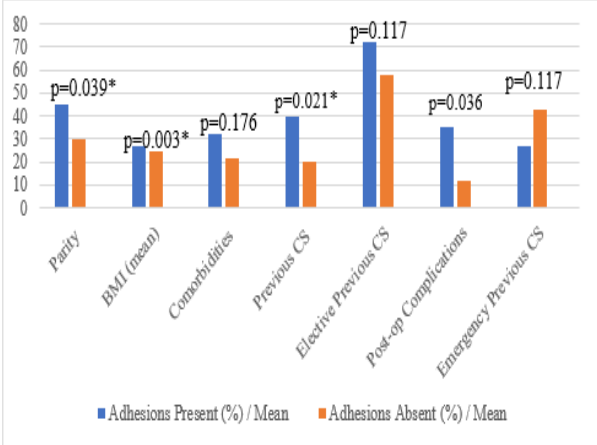

Figure 2: Comparison of key characteristics between women with and without adhesions.

*Significant association

Table 2: Comparison of maternal and surgical characteristics between women with and without adhesions.

Characteristics	Adhesions present (n=35) (%)	Adhesions absent (n=65) (%)	P value
Age (years) (mean±SD)	27.92±4.06	27.66±3.85	0.935[1]
Parity - P1	19 (27.7)	47 (72.3)	0.039[2]
Parity - P2	12 (44.4)	15 (23.1)	
Parity - P3	4 (14.5)	2 (3.1)	
Parity - P4	0 (0.0)	1 (1.5)	
BMI (kg/m²)	25.16±2.57	23.86±2.28	0.003[1]
Comorbidities - yes	7 (33.3)	14 (21.5)	0.176[3]
Comorbidities - no	28 (66.7)	51 (78.5)	
History of pelvi-abdominal surgery - yes	4 (11.4)	3 (4.6)	0.232[3]
History of pelvi-abdominal surgery - no	31 (88.6)	62 (95.4)	
No. of previous caesarean sections - 1	21 (60.0)	54 (83.1)	0.021[2]
No. of previous caesarean sections - ≥2	14 (40.0)	11 (16.9)	
Interpregnancy interval (mean±SD)	4.20±2.44	4.36±2.41	0.642[1]
Nature of preceding caesarean - elective	25 (71.4)	36 (55.4)	0.117[2]
Nature of preceding caesarean - emergency	10 (28.6)	29 (44.6)	
Post-operative complications - present	4 (36.4)	7 (10.8)	0.036[3]

[1]Independent t-test, [2]Chi-square test, [3]Fisher's exact test

Table 3: Impact of adhesion severity on intraoperative outcomes in repeat caesarean section.

Adhesion grade	Mean operative time (min)	Mean Hb drop (g/dl)	Visceral injury (%)
None	38.11 (3.64)	0.65 (0.26)	0 (0.0)
Mild	40.33 (5.50)	0.67 (0.30)	0 (0.0)
Moderate	52.27 (7.54)	1.16 (0.43)	1 (9.1)
Severe	60.56 (8.46)	1.10 (0.25)	4 (44.4)

Table 4: Comparison of surgical outcomes between women with and without adhesions.

Surgical outcome	Adhesions present (n=9)	Adhesions absent (n=65)	P value
Hemoglobin drops (g/dl)	1.10±0.25	0.65±0.26	<0.001[1]
Intra-operative blood transfusion (%)	66.7	7.7	<0.001[2]
Intraoperative injury (visceral/bladder) (%)	44.4	0.0	<0.001[2]
Duration of surgery (minutes)	60.56±8.46	38.11±3.64	<0.001[1]
Duration of hospital stay (days)	6.67±1.66	6.02±2.39	0.106[1]
Post-operative complications (%)	22.2	10.8	0.300[2]

[1]Independent t-test, [2]Fisher's exact test

In summary, our findings highlight the significant impact of adhesion formation on both surgical outcomes and post-operative complications. Higher BMI, a greater number of previous CS, and a higher parity were significant risk factors for the presence of adhesions. Furthermore, adhesions were associated with increased operative time, greater blood loss, and a higher incidence of intraoperative injuries. These findings underscore the need for careful pre-operative planning and surgical technique to mitigate the adverse effects of adhesions in women with a history of multiple CS.

DISCUSSION

This study aimed to explore the association between adhesions and various clinical, demographic, and surgical outcomes in women undergoing cesarean sections. Our results demonstrated significant relationships between adhesions and higher BMI, multiple cesarean sections, increased blood loss, prolonged surgery durations, and greater postoperative complications. These findings are consistent with recent studies, including those by Dawood et al, Badu et al, El-Nashar et al, Ghosh et al, and Morales et al which similarly explore the impact of adhesions on surgical outcomes.[11-15]

Demographic factors and adhesion formation

Our study found a significant association between a higher BMI and the presence of adhesions (25.16 versus 23.86, p=0.003). This result corroborates findings from Dawood et al, who observed that obesity significantly increased the risk of adhesion formation following abdominal surgeries, including CS.[12] Similarly, Badu et al and Ghosh et al reported a clear link between obesity and adhesion development.[11,14] Adiposity contributes to an inflammatory environment in the abdominal cavity, which may lead to fibrosis and increased scar tissue formation post-surgery, facilitating adhesion development. Morales et al also highlighted the significant role of obesity in complicating surgical outcomes by promoting adhesion formation, which often leads to increased intraoperative challenges.[15]

Caesarean section history and adhesions

Our findings indicated a significant association between the number of previous CS and the presence of adhesions (40% versus 16.9%, p=0.021). This result aligns with Dawood et al, who reported that repeated caesarean deliveries increase the risk of developing adhesions.[12] The formation of adhesions after CS is primarily due to scar tissue formation, which becomes progressively more significant with each additional surgery. Similarly, El-Nashar et al and Morales et al found that women with multiple CS have a markedly higher risk of adhesion formation, which complicates future surgeries and raises the likelihood of adverse outcomes, such as organ injury or increased blood loss.[13,15] These studies emphasize the need for careful surgical planning when dealing with women with a history of multiple CS.

Surgical complexity: blood loss and duration

The significant increase in blood loss (hemoglobin drop: 1.10 versus 0.65 g/dl, p<0.001) and longer surgery durations (60.56 versus 38.11 minutes, p<0.001) observed in women with adhesions in this study are consistent with the findings of Ghosh et al and Dawood et al.[12,14] These studies highlighted that the presence of adhesions complicates surgical procedures, leading to longer operative times and increased blood loss due to the difficulty in separating adherent tissues and potential vascular injury. Badu et al similarly observed that the presence of adhesions in CS patients resulted in prolonged surgery durations and higher blood transfusion rates, which is consistent with our findings of a higher rate of intraoperative blood transfusions in women with adhesions (66.7% versus 7.7%, p<0.001).[11] Morales et al also noted that the presence of dense adhesions significantly

increases operative time, further supporting the notion that adhesion-related complications contribute to the prolonged duration of surgery.[15]

Postoperative complications

Our study found that women with adhesions had a significantly higher rate of postoperative complications (36.4% versus 10.8%, p=0.005), which is consistent with findings from Badu et al, Dawood et al, and Ghosh et al.[11,12,14] These studies reported that postoperative complications, including bowel injury, infections, and delayed wound healing, are more common in women with adhesions. Dawood et al found that women with adhesions had an increased risk of gastrointestinal complications due to the distortion of anatomical structures, which can complicate the recovery process.[12] Ghosh et al emphasized that adhesion-related complications can lead to prolonged hospital stays and a longer recovery period.[14] El-Nashar et al also reported an increased risk of wound infections and pelvic abscess formation in patients with extensive adhesions, further supporting the clinical significance of adhesions in postoperative morbidity.[13]

Interestingly, while we observed an increased rate of complications, no significant difference in hospital stay duration or wound sepsis was found in our study. This is in contrast to Badu et al, who reported that adhesions were associated with prolonged hospital stays.[11] This discrepancy could be attributed to differences in post-operative care or management strategies between institutions or to the smaller sample size in our study, which may limit generalizability.

Clinical implications

The findings of this study underscore the importance of considering adhesions as a significant factor in surgical planning, especially in women with multiple CS or those with higher BMI. Given the increased risk of surgical complexity, blood loss, and postoperative complications, clinicians should carefully assess the potential for adhesion formation when planning surgery in this population. Preoperative imaging, such as ultrasound or laparoscopy, may help identify women at higher risk of adhesions, enabling surgeons to tailor their approach accordingly. Morales et al and Dawood et al both suggested that preoperative identification of adhesions and the use of minimally invasive techniques or adhesion barriers may help reduce surgical risks and improve patient outcomes.[12,15]

Limitations and future research

Despite the insights provided, this study has limitations. The relatively small sample size of 100 participants, especially with only 35 having adhesions, may limit the statistical power and generalizability of the findings. Additionally, the retrospective nature of the study means that factors such as surgeon experience, variations in surgical techniques, and post-operative care were not controlled for. Future prospective studies with larger cohorts are necessary to better understand the long-term impact of adhesions on health outcomes. Furthermore, further research is needed to explore the effectiveness of different intervention strategies, such as the use of adhesion barriers or modified surgical techniques, in preventing adhesion formation and minimizing its complications.

CONCLUSION

This study demonstrates that adhesions significantly affect surgical outcomes in women undergoing repeat CS. Adhesions were linked to greater surgical complexity, increased blood loss, longer operative times, and more postoperative complications. With rising caesarean rates, recognizing and addressing the impact of adhesions is essential to improving surgical planning and patient outcomes.

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