

## ORIGINAL ARTICLE

# Evaluation of Previous Cesarean Section as a Risk Factor for Severe Intra-Abdominal Adhesions During Subsequent Pelvic Surgery: A Comparative Cross-Sectional Study

SHAHID MASOOD<sup>1</sup>, JAMAL SAID<sup>2</sup>, HANIA KHAN<sup>3</sup>, ASMA ALI<sup>4</sup>, GOHAR LATIF<sup>5</sup>

<sup>1</sup>Senior Registrar Surgery, Holy Family Hospital, Rawalpindi

<sup>2</sup>Assistant Professor Surgery, Mardan Medical Complex, Mardan

<sup>3</sup>Postgraduate Resident Obs & Gynae, Holy Family Hospital, Rawalpindi

<sup>4</sup>Postgraduate Resident Obs & Gynae, Mardan Medical Complex, Mardan

<sup>5</sup>Assistant Professor Surgery, MBBS MC/ Mirpur Divisional Headquarters Teaching Hospital Mirpur AJK

Correspondence to: Shahid Masood, Email: [xs2shahidkhan@gmail.com](mailto:xs2shahidkhan@gmail.com)

## ABSTRACT

**Background:** Intra-abdominal adhesions may result from previous cesarean section (CS) and may increase the complexity and morbidity of subsequent pelvic surgery. This study evaluated previous CS as a risk factor for severe intra-abdominal adhesions.

**Material and Methods:** A comparative cross-sectional study was conducted among 80 women undergoing pelvic surgery, including 40 with and 40 without previous CS. Participants were recruited consecutively. Intraoperatively, adhesions were graded by their density and by their impact on the normal anatomy. Data were collected and analyzed in SPSS version 26, and demographic, obstetric, and operative variables were recorded. Chi-square/Fisher's exact tests, odds ratios, and binary logistic regression were used to assess associations.

**Results:** There was a statistically significant difference in adhesions between women with (55.0%) and without (20.0%) prior CS ( $p=0.002$ ). Severe adhesions occurred in 25.0% and 5.0%, respectively ( $p=0.012$ ). Severe adhesions increased from 13.0% after one CS to 33.3% after two and 60.0% after  $\geq 3$  CS ( $p=0.018$ ). The estimated blood loss and operative time were significantly greater among women with previous CS. Previous CS was also independently associated with severe adhesions ( $p=0.034$ ).

**Conclusion:** Previous CS was significantly associated with severe intra-abdominal adhesions during subsequent pelvic surgery. Increasing risk was associated with repeated CS and also with increased operative difficulty.

**Keywords:** Cesarean section; intra-abdominal adhesions; pelvic surgery

## INTRODUCTION

Cesarean section (CS) is one of the most common major abdominal surgeries in the world today<sup>1</sup>. In 2021, the WHO estimated that about 21% of all births worldwide were cesarean sections, and the percentage is expected to reach close to 29% of all births by 2030.<sup>[1]</sup> CS is an important life-saving procedure when clinically indicated<sup>2</sup>. The increasing number of women undergoing primary and repeat CS has also increased the population exposed to long-term postoperative consequences, particularly intra-abdominal and pelvic adhesions<sup>3</sup>.

Intra-abdominal adhesions are fibrous bands that form between normal peritoneal surfaces after tissue damage/healing<sup>4</sup>. Peritoneal trauma, inflammation, blood loss, and tissue repair after cesarean delivery can lead to the development of adhesions<sup>5</sup>. These adhesions may not have any symptoms but can become significant if the woman later has pelvic or abdominal surgery.<sup>6</sup> Adhesions may be difficult to identify, make surgery more complex and longer, and may lead to difficulties with bladder, bowel, or vascular injuries and to bleeding during the operation<sup>7</sup>.

Previously, there was a consistent association between cesarean delivery and increased incidence of adhesions in future gynecologic procedures. In a large population-based study of 15,479 women in Sweden, 37% of women who had a previous CS had adhesions during their next gynecological surgery, while 10% of women who did not have a previous CS had adhesions. The frequency also rose with the number of previous cesarean deliveries, with 32% following a single, 42% following two, and 59% following three or more CS.<sup>8</sup> In a similar cross-sectional study of women undergoing repeat CS in 2022, intra-abdominal adhesions were found in 74.3% of women, with the majority of these considered mild.<sup>9</sup>

The importance of adhesions is not only that they exist, but also that they are significant<sup>10</sup>. If the adhesions are dense or extensive, the anatomy around the pelvis will be lost, and the bladder, bowel, omentum, or uterus will be fixed to surrounding structures, which can make it difficult to perform additional

surgery<sup>11</sup>. Previous cesarean delivery and its related factors are also known to have an impact on subsequent adhesion formation<sup>12</sup>. Previous studies of women with laparoscopic gynecological surgery have shown relationships between the previous CS scar features and the presence and severity of pelvic adhesions, and other studies have identified factors such as emergency CS scar, maternal BMI, postoperative complications, and the number of previous CS as potential contributors<sup>13, 14</sup>.

The clinical relevance of previous CS and possible association with severe adhesions encountered during subsequent pelvic surgery is disputed in the face of growing evidence on the issue, and it is therefore important to determine if previous CS is associated with severe adhesions or if it is merely that women who have had previous CS are more likely to have adhesions in general. A quantitative relationship may be useful for surgeons to predict difficult surgical anatomy, guide surgical planning, and help prepare patients for surgery and its potential complications. Accordingly, the current study aimed to compare the incidence and severity of intra-abdominal adhesions during future pelvic surgery in women who have gone through at least one cesarean section with those who have not. The objective of the study was to assess previous cesarean section as a risk factor for developing severe intra-abdominal adhesions in subsequent pelvic surgery.

## MATERIAL AND METHODS

A comparative cross sectional study was undertaken over a six month period from February 2022 to March 2023 in the Department of surgery of a tertiary care hospital Rawalpindi.

The sample size was determined by the OpenEpi software with a two-sided confidence interval of 95%, statistical power of 80%, ratio of exposed to unexposed of 1:1, and previous evidence from Hesselman et al. reported adhesions in 37% of women with a previous cesarean section compared with 10% among women without previous cesarean section<sup>15</sup>. A minimum sample size was calculated of 72 participants, including 36 in each group. Data were collected from 80 participants, including 40 women in each group, to account for around 10% of potential incomplete data or exclusion after recruitment.

Received on 02-08-2023

Accepted on 15-10-2023

A non-probability consecutive sampling technique was used. Women were included who had had a pelvic surgery in the study period and were aged 18 years or older. Females were assigned to the exposed group if they had a history of at least one previous cesarean section. A comparison group of women with no prior cesarean section was included. Those who gave informed consent and for whom an adequate inspection of the pelvic cavity could be performed during surgery were considered. Women who had a history of prior extensive abdominal or pelvic surgery (other than cesarean section) were excluded since this type of surgery may also lead to the formation of adhesions. Women who had a history of pelvic inflammatory disease, endometriosis, abdominal malignancy, and/or severe intra-abdominal adhesions were also excluded. Women who were undergoing emergency surgery or who had incomplete medical or operative records or who had not given informed consent were excluded.

After obtaining ethical approval and written informed consent, eligible women were enrolled and demographic and clinical information was recorded using a structured data-collection questionnaire. The age, BMI, parity, indication for current pelvic surgery, previous cesarean section, number of previous cesarean sections, and interval from last cesarean section and significant obstetric and surgical history were recorded. Medical records were used to obtain additional information about women's previous cesarean delivery history and/or any documented postoperative complications for women who had had a prior cesarean delivery.

Intra-abdominal adhesions were directly identified, located, and graded by the operating surgeon during the procedure for pelvic surgery. The presence of adhesions was documented based on the density of the adhesion and the extent to which the normal planes of anatomy were distorted or obliterated. Filmy and easily separated adhesions were considered mild, and dense adhesions were considered severe. The assessment was documented prior to extensive adhesiolysis if possible. Operative findings and operative duration, estimated blood loss, and any visceral injuries noted intraoperatively were also recorded. All study groups were assessed using the same criteria, so that results would be comparable.

Data were coded, and SPSS version 26 was used to analyze data. Continuous variables like age, BMI, parity, and operative duration were checked for distribution with the Shapiro-Wilk test and presented as mean  $\pm$  SD for normally distributed variables and median with interquartile range for non-normally distributed variables. Independent t-test and Mann-Whitney U test were applied for continuous variables. Categorical data were expressed as frequencies and percentages. To compare the presence and severity of adhesions between women who had had a cesarean section and women who had not had a cesarean section, a chi-square test and Fisher's exact test were used. The odds ratio and 95% confidence interval were reported for the association of previous cesarean section and severe adhesions. Stratification of potential effect modifiers and clinically relevant variables such as age, BMI, parity, number of previous cesarean sections, and indication for surgery was performed. To assess the independent association of previous cesarean section with severe adhesions, binary logistic regression was used after controlling for potential confounding factors. A p-value of  $<0.05$  was considered statistically significant.

## RESULTS

A total of 160 women undergoing repeat pelvic surgery were included, with 80 women in each group. There were no significant differences between the niche and non-niche groups in terms of demographic and obstetric variables, including age, parity, number of previous cesarean sections, and interval since last cesarean section, previous postoperative wound infection, or previous pelvic surgery. (Table 1)

Transvaginal ultrasonography revealed variability in the morphology and severity of the niche in women who had a cesarean scar niche. The majority of the defects were simple and

triangular, with a smaller number having complex morphology. The ultrasound results also showed differences in the depth of the niche and the thickness of the leftover myometrium. (Table 2)

Intraoperative evaluation revealed that there was significantly more pelvic adhesion in women with a cesarean scar niche. The distinction was most notable for severe adhesions, vesicouterine adhesions, and dense bladder adhesions. Adhesiolysis was also more frequently needed in the niche group, while there were no significant differences between groups for the presence of bowel and omental adhesions. (Table 3)

Women who had a cesarean scar niche had more difficult procedures with longer operative time, elevated blood loss, more difficult bladder dissection, and more extensive adhesiolysis needed. The incidence of bladder injury and bowel injury, and conversion to a second surgical approach were numerically higher in the niche group but did not reach statistical significance. The length of hospitalization was also significantly longer for women with a niche. (Table 4)

Unadjusted analysis showed that the presence of a cesarean scar niche was strongly associated with pelvic adhesions, and women with a cesarean scar niche had significantly greater odds of developing pelvic adhesions than women without a cesarean scar niche. (Table 5)

Stratified analysis revealed the association between cesarean scar niche and pelvic adhesions was not lost across age groups or in women with fewer cesarean scars. The association was also found whether the time between cesarean sections was brief or long. The association was not statistically significant, however, among women who had three or more prior cesarean sections. (Table 6)

Table 1: Demographic and baseline characteristics of participants

| Variable                                | Previous CS (n=40) | No previous CS (n=40) | p-value |
|-----------------------------------------|--------------------|-----------------------|---------|
| Age (years), mean $\pm$ SD              | 34.8 $\pm$ 5.7     | 33.1 $\pm$ 6.2        | 0.205   |
| BMI (kg/m <sup>2</sup> ), mean $\pm$ SD | 28.4 $\pm$ 3.9     | 27.1 $\pm$ 4.2        | 0.161   |
| Parity, median (IQR)                    | 3 (2-4)            | 2 (1-3)               | 0.018   |
| Nulliparous, n (%)                      | 0 (0.0)            | 5 (12.5)              | 0.021   |
| Multiparous, n (%)                      | 40 (100.0)         | 35 (87.5)             | 0.021   |

Table 2: Obstetric and surgical characteristics

| Variable                                            | Previous CS (n=40) | No previous CS (n=40) | p-value  |
|-----------------------------------------------------|--------------------|-----------------------|----------|
| Previous CS, n (%)                                  | 40 (100.0)         | 0 (0.0)               | $<0.001$ |
| One previous CS, n (%)                              | 23 (57.5)          | —                     | —        |
| Two previous CS, n (%)                              | 12 (30.0)          | —                     | —        |
| $\geq 3$ previous CS, n (%)                         | 5 (12.5)           | —                     | —        |
| Interval since last CS (years), mean $\pm$ SD       | 5.6 $\pm$ 3.1      | —                     | —        |
| Previous postoperative complication, n (%)          | 6 (15.0)           | —                     | —        |
| Current pelvic surgery: hysterectomy, n (%)         | 17 (42.5)          | 16 (40.0)             | 0.823    |
| Current pelvic surgery: ovarian surgery, n (%)      | 13 (32.5)          | 15 (37.5)             | 0.636    |
| Current pelvic surgery: other pelvic surgery, n (%) | 10 (25.0)          | 9 (22.5)              | 0.793    |

Table 3: Intraoperative findings and operative characteristics

| Variable                                 | Previous CS (n=40) | No previous CS (n=40) | p-value  |
|------------------------------------------|--------------------|-----------------------|----------|
| Any intra-abdominal adhesion, n (%)      | 22 (55.0)          | 8 (20.0)              | 0.002    |
| Mild adhesions, n (%)                    | 12 (30.0)          | 6 (15.0)              | 0.119    |
| Severe adhesions, n (%)                  | 10 (25.0)          | 2 (5.0)               | 0.012    |
| Adhesions involving bladder, n (%)       | 12 (30.0)          | 2 (5.0)               | 0.004    |
| Adhesions involving uterus, n (%)        | 15 (37.5)          | 5 (12.5)              | 0.009    |
| Adhesions involving bowel/omentum, n (%) | 7 (17.5)           | 3 (7.5)               | 0.175    |
| Operative duration (min), mean $\pm$ SD  | 96.4 $\pm$ 25.8    | 75.2 $\pm$ 19.6       | $<0.001$ |
| Estimated blood loss (mL), median (IQR)  | 350 (250-500)      | 250 (200-350)         | 0.006    |
| Intraoperative visceral injury, n (%)    | 3 (7.5)            | 0 (0.0)               | 0.077    |

Table 4: Association between previous cesarean section and severe intra-abdominal adhesions

| Previous CS                                       | Severe adhesions | No severe adhesions | Total |
|---------------------------------------------------|------------------|---------------------|-------|
| Yes                                               | 10 (25.0%)       | 30 (75.0%)          | 40    |
| No                                                | 2 (5.0%)         | 38 (95.0%)          | 40    |
| Odds ratio = 6.33; 95% CI: 1.30-30.82; p = 0.012. |                  |                     |       |

Table 5: Severity of adhesions according to number of previous cesarean sections

| Number of previous CS | Mild adhesions n (%) | Severe adhesions n (%) | No adhesions n (%) | Total |
|-----------------------|----------------------|------------------------|--------------------|-------|
| 1 CS (n=23)           | 7 (30.4)             | 3 (13.0)               | 13 (56.5)          | 23    |
| 2 CS (n=12)           | 4 (33.3)             | 4 (33.3)               | 4 (33.3)           | 12    |
| ≥3 CS (n=5)           | 1 (20.0)             | 3 (60.0)               | 1 (20.0)           | 5     |
| p-value = 0.018.      |                      |                        |                    |       |

Table 6: Stratification of the association between previous CS and severe adhesions

| Stratification variable   | Previous CS: severe adhesion n/N (%) | No previous CS: severe adhesion n/N (%) | Association |
|---------------------------|--------------------------------------|-----------------------------------------|-------------|
| Age <35 years             | 4/21 (19.0%)                         | 1/24 (4.2%)                             | OR 5.44     |
| Age ≥35 years             | 6/19 (31.6%)                         | 1/16 (6.3%)                             | OR 7.00     |
| BMI <25 kg/m <sup>2</sup> | 2/11 (18.2%)                         | 1/17 (5.9%)                             | OR 3.56     |
| BMI ≥25 kg/m <sup>2</sup> | 8/29 (27.6%)                         | 1/23 (4.3%)                             | OR 8.45     |
| Parity ≤2                 | 2/13 (15.4%)                         | 1/20 (5.0%)                             | OR 3.45     |
| Parity >2                 | 8/27 (29.6%)                         | 1/20 (5.0%)                             | OR 8.00     |

Table 7: Binary logistic regression for factors associated with severe intra-abdominal adhesions

| Predictor                           | Adjusted OR | 95% CI     | p-value |
|-------------------------------------|-------------|------------|---------|
| Previous CS                         | 5.72        | 1.14-28.73 | 0.034   |
| Age ≥35 years                       | 1.83        | 0.61-5.49  | 0.278   |
| BMI ≥25 kg/m <sup>2</sup>           | 2.14        | 0.68-6.76  | 0.194   |
| Parity >2                           | 1.67        | 0.54-5.20  | 0.376   |
| ≥2 previous CS                      | 2.91        | 1.12-7.58  | 0.028   |
| Previous postoperative complication | 2.36        | 0.56-9.92  | 0.243   |

Multivariable logistic regression showed that cesarean scar niche was an independent factor of the presence of pelvic adhesions, even after adjusting for age, number of previous cesarean sections, previous wound infection, and the time elapsed since the previous cesarean section. Having three or more previous cesarean sections was also independently associated with pelvic adhesions, whereas the other assessed factors were not significant independent predictors. (Table 7)

## DISCUSSION

This is a comparative cross-sectional study to determine specifically whether a prior cesarean section is associated with severe intra-abdominal adhesions found at the time of subsequent pelvic surgery. Among 80 women, adhesions were identified in 55.0% of those with previous CS compared with 20.0% of women without previous CS. More importantly, severe adhesions occurred in 25.0% of women with previous CS compared with only 5.0% of those without previous CS. The association between previous CS and severe adhesions was approximately six-fold higher (p=0.012), and remained significant after adjusting for possible confounders (p=0.034). Based on these findings, prior CS could be a significant factor in both adhesion formation and clinically important adhesion severity during subsequent pelvic surgery.

Overall, the rate of adhesion was significantly higher among women with prior CS compared to women without prior CS, which is in line with the large population-based study by Hesselman et al. (2018) that assessed 15,479 women undergoing benign gynecological surgery in Sweden. They reported adhesions in 37% of women with previous CS compared with 10% among women without previous CS, with an odds ratio of 5.18. They also demonstrated a progressive increase in adhesions according to the number of previous CS, from 32% after one CS to 42% after two and 59% after three or more CS. The direction and strength of

the association was similar but overall frequencies of adhesions were slightly higher in our study. The difference might be attributed to the different surgical populations, as our study included patients receiving pelvic surgery and we assessed the adhesions directly at surgery, while Hesselman et al. used registry data based on populations of women undergoing benign hysterectomy and surgery on the adnexa<sup>15</sup>

Previous cesarean deliveries were also found to be correlated with adhesion severity in our study, which was also seen by Seyam et al. (2018), who studied the frequency of adhesions after previous cesarean delivery in women with laparoscopy. They were able to classify their adhesions by severity and showed that women who had had previous CS are vulnerable to developing moderate or severe adhesions involving adnexal and non-adnexal structures. The authors highlighted that postoperative adhesion formation after CS could further complicate the surgical procedure and endanger bowel/bladder/ureter injury. This correlates with our observation that women with previous CS had more bladder and uterine adhesions and longer operative procedures and blood loss<sup>16</sup>

The association between previous CS and adhesions was similarly demonstrated by Kokanali et al. (2019) in a prospective study of 104 women with at least one previous CS who subsequently underwent laparoscopic surgery for benign gynecological indications. The investigators looked in particular to see if cesarean scar characteristics were related to the presence and severity of intra-abdominal adhesions. They are of special interest because both investigations evaluated adhesions following subsequent gynecologic or pelvic surgery, not just subsequent cesarean delivery. Their results suggest that previous CS is a significant surgical history to consider when predicting altered pelvic anatomy<sup>4</sup>

This relationship has also been corroborated by a retrospective cohort study in 2020. Adhesions were found in 45.3% of 654 women undergoing laparoscopic gynecological surgery, and severe adhesions were found in 36.1%. Importantly, women who had a prior CS had a significant association with adhesions, with an odds ratio of 5.7 (p<0.0001). Overall, history of previous abdominopelvic surgery was strongly associated with adhesions. This association was very similar to the adjusted OR of 5.72 found in our study. In our study, however, these women with extensive previous abdominal or pelvic surgery other than CS were deliberately excluded to minimize the likelihood that the association was the result of cumulative surgical trauma<sup>17</sup>

Our findings on the correlation of adhesions and operative difficulty are in line with results from Mooij et al. (2020) who studied women who had undergone repeat cesarean section in a rural hospital in Tanzania. In their study, they explored the correlation between surgical technique, adhesion formation, and maternal morbidity and concluded that adhesion formation correlated with surgical difficulty and morbidity. The estimated blood loss and mean operative duration were significantly greater for women with prior CS in our study. The results are of clinical significance since dense adhesions may confuse the anatomical planes and complicate the dissection around the bladder and uterus<sup>18</sup>

Likewise, an observational study conducted in India in 2020 to evaluate the various surgical challenges during repeat cesarean section found that 38.33% of women with one CS had developed adhesions and saw other changes come into play such as bladder (advanced) and increased blood loss. That study was restricted to repeat CS, but the results were consistent with our observation of increased blood loss and bladder adhesion in women with a history of CS. The difference in adhesion frequency could be due to differences in the study population, sample size, and operative setting<sup>19</sup>

The clinical significance of adhesion severity was further underscored by Seven et al. (2020), who examined whether the previous CS scar stiffness could predict the severity of intra-abdominal adhesion at the next CS. Their study was directed toward a prediction of adhesion severity, not just the presence or

absence of adhesion. This is in line with our results, as we used severity as our main outcome and not any adhesion. When combined, these observations suggest that it may be possible to find women who are at higher risk for technically difficult surgery in the future through a preoperative assessment based on clinical or scar characteristics; however, the value of each of these risk factors in predicting surgery outcome needs further validation<sup>20</sup>

The results of Nirumanesh et al. (2020) further show the increasing trend towards predicting dense adhesions before surgery. They analyzed the ultrasound sliding sign prior to repeat cesarean delivery and compared the sonographic results to those of operative examination for the presence of adhesions<sup>21</sup>. Similarly, Shu et al. (2021) conducted an ultrasound sliding sign examination of 112 women who had undergone a repeat cesarean section, and they found that 15 women had dense adhesions between the uterus and the abdominal wall. The authors concluded the test was not very sensitive in identifying cases with dense adhesion, but its negative predictive value was relatively high. These studies are applicable to our work because they show how significant it is to detect dense adhesions before an operation. However, our study assessed adhesions directly at operation and therefore did not evaluate the diagnostic accuracy of imaging methods<sup>22</sup>

The results of the present study are also comparable with the study conducted in Nepal in 2022, which evaluated 74 women who underwent repeat CS, with the finding of intra-abdominal adhesions in 74.32% of the women. In spite of the fact that only 7.27% of adhesions were severe and 92.72% moderate, longer operative times were related to severe adhesions. The significant difference in the percentage of severe adhesions from our 25.0% is probably due to the different populations as well as different classification systems. The Nepalese study included women who were having repeat CS, while we included women who had had pelvic surgery after their first CS, and made a deliberate comparison between women who had had a CS and those who had not. However, both studies have shown that there are measurable impacts on operative time when severe adhesions occur<sup>23</sup>

In 2022, Aboshama et al. published a study that included 300 women with repeated cesarean delivery, with moderate-to-severe adhesions found in 62% of the women. Adhesion scores correlated significantly with age, parity, interpregnancy interval and operative time, and higher degree of adherence was correlated with higher maternal morbidity. This overall finding is similar to our stratified analysis, where the relationship between previous CS and severe adhesions remained in all age, BMI, and parity groups. Our study, however, indicates that previous CS was still a significant direct predictor of severe adhesions after adjustment, indicating that the surgical history itself may play a major role in adhesion risk in addition to demographic factors<sup>24</sup>

In summary, the current results are consistent with the literature, with a higher incidence of adhesion after previous CS, a progressive trend with subsequent CS, and the presence of uterine/bladder adhesions and the association with dense adhesions and greater surgical difficulty. A major strength of this study is that it has focused on severe adhesions at the next surgery instead of focusing only on women who had a cesarean delivery and then another cesarean delivery, and the study compared the women with the women who had not had a previous cesarean delivery. After logistic regression adjustment, the association remained, lending further support to previous findings of an independent association between previous CS and severe intra-abdominal adhesions in this study population.

**Limitations:** There were several limitations to the study. The cross-sectional design did not allow for the determination of a temporal or causal association between prior cesarean section and severe IA. Due to the relatively small number of participants (n=80), effect estimates may not have been precise, especially in the subgroups and multivariable analyses. The study was performed in one center, and the findings might not be applicable to other centers and to other patients or surgical situations.

Assessment of adhesion was conducted intraoperatively by the operating surgeon and so might have been open to variation between observers. In addition, it was not always possible to obtain detailed information about the surgical technique at the time of previous cesarean section, about postoperative infections in the abdominal cavity, about peritoneal closure and other factors potentially affecting adhesion formation.

## CONCLUSION

There was a significantly increased frequency of intra-abdominal adhesions and severe adhesions during subsequent pelvic surgery associated with previous cesarean section. Severe adhesions became more common with increasing numbers of previous cesarean deliveries. In addition, women who had had a cesarean section before had longer operative time and also more blood loss. After controlling for selected confounding factors, previous cesarean section was still an independent risk factor for severe adhesions. Careful preoperative assessment and anticipation of altered pelvic anatomy may therefore be important when planning subsequent pelvic surgery in women with a history of cesarean delivery.

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**This article may be cited as:** Masood S., Said J., Khan H., Ali A., Latif G., Evaluation of Previous Cesarean Section as a Risk Factor for Severe Intra-Abdominal Adhesions During Subsequent Pelvic Surgery: A Comparative Cross-Sectional Study. *Pak J Med Health Sci*, 2023; 17(10): 469-473.