

## THE EFFECT OF CLOSURE OF PERITONEUM AND ANATOMICAL LAYERS ON ADHESION FORMATION IN PATIENTS UNDERGOING CESAREAN SECTION

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### Keywords

Cesarean section,  
Adhesion incidence,  
Peritoneal closure,  
Operative time

### ABSTRACT

*This study is to investigate the effect of closure of the peritoneum and other anatomical layers on adhesion formation in patients undergoing cesarean section, and to compare the effect of different closure of layers on adhesion formation. The operation notes of 1021 patients were retrospectively analyzed and the abdominal closure technique in the previous cesarean section was recorded. Presence and severity of adhesion in the second cesarean section was recorded using the NAIR's classification which was previously defined by the same operator. Four groups were formed according to the closure technique and the groups were compared with each other according to the adhesion scale recorded during the second cesarean section. There was no statistically significant difference between the groups in terms of age, BMI, number of pregnancies and cesarean section. Among the 4 groups formed according to the closure technique, the rate of adhesion formation was statistically the highest in the group in which the fascia was closed directly after the closure of uterus. Adhesion formation has decreased significantly as the number of sutured anatomical layers increased. Adhesion severity was found to be statistically significantly higher in the direct closure group. As the number of sutured layers increased, the severity of adhesion was found to be significantly lower. The operative time was found to be significantly longer as the severity of adhesion. Although not statistically significant, two major organ injuries occurred in the group without layered closure. The second operative time was found to be significantly higher as the severity of adhesion increased.*

### INTRODUCTION

Peritoneal adhesions are defined as pathological fibrotic bands formed between two surfaces within the peritoneal space<sup>1</sup>. The development of adhesion may be due to different reasons. Although adhesions are often due to a surgical intervention; peritonitis, endometriosis, pelvic inflammatory disease, long-term peritoneal dialysis, chemical peritonitis, radiotherapy and cancer can also cause adhesions<sup>2,3,4</sup>. At least one of these two surfaces must have a mesothelial damage for the development of adhesion<sup>5</sup>. Fibrinous exudate is released a few hours after mesothelial damage. Fibrous bands and newly formed capillaries are left behind after the absorption of exudate. These structures form the permanent fibrotic adhesions<sup>5,6</sup>. These adhesions can cause mechanical intestinal obstructions, secondary infertility and chronic abdominal pain. In addition, they increase the possibility of iatrogenic injury when intra-abdominal surgical intervention is required<sup>7</sup>. Many substances, including steroid and non-steroidal anti-inflammatory agents, have been used experimentally to prevent intra-abdominal adhesions. However, their use in clinical practice has been limited due to their systemic side effects<sup>8</sup>.

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Adhesions can also be seen after cesarean section and the rate of adhesions increases as the number of cesarean section operations increases. However, cesarean section differs from other abdominal and gynecological operations. All the factors such as removal of abdominal and pelvic organs from the surgical field by pregnant uterus, not applying primary surgery to organs with frequent adhesions such as omentum and ovary, changes in fibrin and fibrinolytic system as a result of physiological changes during pregnancy, change in the levels of adhesion molecules and chemotactic cellular mediators, the rapid entrance to the abdomen and therefore the relatively high tissue damage, presence of blood, clots and amniotic fluid in the peritoneal cavity, distinguishes cesarean section from other surgical procedures in terms of adhesion formation<sup>9</sup>.

Postoperative intra-abdominal adhesions significantly affect quality of life in patients undergoing abdominal surgery and is still an important problem today. Despite the shortening of the operative time, the anti-infectious agents used, technological developments in suture materials, the incidence of adhesion is still at substantial levels.

There are many studies about adhesion. However, the materials used in these studies, which are still referenced, are not being used nowadays. Besides, antibiotics that were not used in out-of-date studies are currently used prophylactically, which reduces the incidence of adhesion. Suture materials have been replaced by synthetic materials with technological developments that cause less reaction and are absorbed faster. At the same time, with this progress, talcum powder, which is used in gloves and known to cause adhesion, is no longer used.

Surgical success increases and adhesions and complications decrease as a result of the positive developments in the pharmaceutical and medical materials industry. The aim of this study is to determine the conditions that may cause adhesion due to surgical technique by reviewing the intraoperative processes with these developments and minimizing the surgeon factor for the adhesion and further reducing the adhesions.

## MATERIALS AND METHODS

Our single-center, prospective clinical study included 1021 patients with a previous cesarean section who applied to Private Sivas Medica

Hospital to give birth between November 2019 and November 2022 and were planned to have a second cesarean delivery with this indication.

Patients to whom an anti-adhesion barrier was used in their previous cesarean section, patients who have undergone different surgeries that may increase adhesion formation other than cesarean section, patients who have undergone abdominal surgery with another indication such as myomectomy, ovarian surgery, appendectomy, patients with a previous history of abscess or pelvic inflammatory disease (PID), patients with systemic disease such as endometriosis, collagen tissue disease, systemic lupus erythematosus, vasculitis and diabetes, and patients who underwent additional surgery (e.g, myomectomy, oophorectomy, cystectomy, drain placement) in a previous cesarean section were not included in this study. All patients who met the inclusion criteria were informed before participation and their consent was obtained. The study was carried out in accordance with the Declaration of Helsinki, after taking the approval of local ethics committee. Demographic data of all patients included in the study, such as age, body mass index (BMI), gravida, parity, and the number of previous cesarean sections were noted.

The previous surgery notes of the cases were reviewed. It was recorded whether visceral peritoneum, parietal peritoneum and muscle closure was performed, and if so, with which material. Since it was determined that similar materials were used in peritoneal and muscle closure, material comparison was not considered necessary. The patients were divided into 4 groups according to these records:

Preoperative grouping of patients according to their previous operation notes:

1. Group 1: Patients in whom the fascia was closed directly without closing the peritoneum and muscle (n=256)
2. Group 2: Patients in whom only the parietal peritoneum was closed (n=251)
3. Group 3: Patients with closure of the parietal and visceral peritoneum (n=261)
4. Group 4: Patients with closure of parietal, visceral peritoneum and muscle (n=257)

All patients' adhesions during the second operation were recorded in written and visually by a single operator. The duration of the second

operation performed by the same operator was also recorded. The presence and severity of adhesions formed after the first operation were graded intraoperatively by the operator using the NAIR classification system<sup>6</sup>. According to this classification, patients were evaluated in terms of intra-abdominal adhesions as follows:

Grade 0: no adhesion;

Grade 1: single adhesive band between organs or between organs and abdominal wall;

Grade 2: Two adhesive bands between organs or between organs and abdominal wall;

Grade 3: more than 2 adhesive bands between organs or between organs and abdominal wall;

Grade 4: adherence of an organ directly to the abdominal wall, regardless of the number of adhesive bands.

The groups were compared in terms of operative time and presence of a relationship between the number closed layers and adhesion scores.

SPSS for Windows 22.00 statistical program was used in the analysis of the data obtained in the study. Frequency analysis, percentage analysis, Pearson Product-Moment correlation analysis, One-Way Analysis of Variance ANOVA, Bonferroni Post Hoc test, Chi-square test were used in the analysis of the data.  $P < 0.05$  was considered statistically significant.

**RESULTS**

There was no statistically significant difference between the groups in terms of age, BMI (body mass index), number of pregnancies and cesarean section ( $p > 0.05$ ) (Table 1).

**Table 1.** Comparison of surgical groups in terms of age, BMI, number of pregnancies, number of cesarean sections.

	Group 1	Group 2	Group 3	Group 4	P value
<b>Age</b>	32,11±4,63	32,05±4,76	32,22±4,83	31,93±4,86	p=,926
<b>BMI</b>	33,14±2,95	33,27±3,01	33,16±2,99	33,04±2,99	p=,861
<b>Number of pregnancies</b>	2,00±,000	2,00±,000	2,00±,000	2,00±,000	*
<b>Number of cesarean section</b>	1,00±,000	1,00±,000	1,00±,000	1,00±,000	*

\* Since the mean of all groups was the same, analysis could not be performed. Data are presented as Median±standard deviation( $X \pm SD$ ). No statistical difference was found between the groups ( $P < 0.05$ ).

There was no adhesion in 649 patients (63.6%) and adhesion was present in 372 patients (36.4%). Adhesion was observed in 83.5% of the patients in Group 1, 42% of the patients in Group 2, 11.2% of the patients in Group 3, and 9.8% of

the patients in Group 4. The difference between the groups in terms of adhesion was found to be statistically significant ( $p < 0,05$ ). According to this, adhesion is observed mostly in Group 1 patients and least in Group 4 patients (Table 2).

**Table 2.** Comparison of surgical groups in terms of presence of adhesion.

Surgical group	Presence of adhesion	n	%	P value
<b>Group 1</b>	Yes	213	83,5	p=,000
	No	42	16,5	
<b>Group 2</b>	Yes	105	42,0	p=,000
	No	145	58,0	
<b>Group 3</b>	Yes	29	11,2	p=,000
	No	231	88,8	
<b>Group 4</b>	Yes	25	9,8	p=,000
	No	231	90,2	

\*  $P < 0.5$  was accepted as significant.

The severity of adhesion in patients was determined according to the NAIR classification system as follows: Grade 1: 251 patients (67.5%), Grade 2: 58 patients (15.6%), Grade 3: 41 patients (11%), Grade 4: 22 patients (5.9%). According

to these results, the severity of adhesion was found to be mild in the majority of patients. The difference between the groups in terms of the severity of adhesion was found to be statistically significant ( $p < 0,05$ ) (Table 3).

**Table 3.** Comparison of surgical groups in terms of adhesion severity.

Adhesion grade	Grade 1		Grade 2		Grade 3		Grade 4		P value
	n	%	n	%	n	%	n	%	
<b>Group 1</b>	111	52,1	46	21,6	34	16,0	22	10,3	$p = ,000$
<b>Group 2</b>	95	90,5	6	5,7	4	3,8	0	0,00	$p = ,000$
<b>Group 3</b>	26	89,7	0	0,00	3	10,3	0	0,00	$p = ,000$
<b>Group 4</b>	19	76,0	6	24,0	0	0,00	0	0,00	$p = ,000$

\*  $P < 0.5$  was accepted as significant.

Adhesion severity was found to be Grade 1, Grade 2, Grade 3 and Grade 4 in 52.1%, 21.6%, 16%, and 10.3% of patients in group 1, respectively. Adhesion severity was found to be Grade 1, Grade 2 and Grade 3 in 90.5%, 5.7%, 3.8% of patients in group 2, respectively. Adhesion severity was found to be Grade 1 and Grade 3 in 89.7% and 10.3% of patients in group 3, respectively. Adhesion severity was found to be Grade 1 and Grade 2 in 76.0% and 24.0% of patients in group 4, respectively (Table 3).

The mean operative time of patients with Grade 1, Grade 2, Grade 3 and Grade 4 adhesions was found as 33.88, 37.71, 44.76 and 58.14 minutes, respectively. The time differences between the groups were found to be statistically significant ( $p < 0,05$ ). It has been determined that there is a correct relationship between the severity of adhesion and the duration of the operation ( $r = ,81$ ,  $p < 0.05$ ). As a result, it can be said that the severity of adhesion and the duration of the operation increase simultaneously (Table 4).

**Table 4.** Findings related to the differences in terms of operation time according to the severity of adhesion of the patients included in the study.

Surgical group	n	Duration of surgery	P value
<b>Group 1</b>	251	33,88±2,87	$p = ,000$
<b>Group 2</b>	58	37,71±4,92	
<b>Group 3</b>	41	44,76±2,46	
<b>Group 4</b>	22	58,14±11,41	

\* Data are presented as Median±standard deviation( $X \pm SD$ ).  $P < 0.5$  was accepted as significant.

## DISCUSSION

Adhesions after cesarean section are an important problem due to increased time to reach the abdomen and uterine cavity during repeated cesarean section operations, difficulty in exploring the abdominal cavity, Injuries to surrounding organs during adhesiolysis and making it difficult to suture the uterus outside the abdomen.

The incidence of adhesion after cesarean section has been reported as 43% (16% thin and 27% thick adhesion)<sup>10</sup>. In another study, pelvic adhesions were shown to occur at a rate of 46% after the first cesarean, 75% after the second cesarean, and 83% after the third cesarean<sup>11</sup>. Again, in a prospective cohort analysis, adhesion was observed in 52% of cesarean sections with closed parietal peritoneum and 73% in non-closure cesarean sections<sup>12</sup>.

In our study, the incidence of adhesion was determined as 36.4% in all patients. The incidence of adhesion was 83.5% in the group where the layers were not closed, and 9.8% in the group where all layers were closed. The incidence of adhesion after intra-abdominal surgery is 67-93% in the surgical literature<sup>13</sup>. This difference in adhesion formation may be due to the fact that the pregnant uterus pushes the abdominal and pelvic organs away from the surgical field. The formation of fibrin bands during adhesion development, migration of cellular elements, and organization of fibrin bands as a result of ischemia or a decrease in fibrinolytic activity occur in the early postoperative period. The post-cesarean involution process of the uterus keeps the surrounding organs and intestines away from the uterine incision line. In addition, fibrinolytic activity and changes in adhesion molecules in the amniotic fluid and membrane during pregnancy may cause less adhesions after cesarean section<sup>14</sup>. In an animal study in rats, it was shown that the human amniotic membrane prevents the formation of adhesion<sup>15</sup>.

There are also studies in the literature showing that the peritoneal closure increases the formation of adhesion<sup>16</sup>. We know that infection, which is one of the most effective causes of adhesions, cannot be controlled in a study of Conolly et al. in 1968 as well as today. In addition, this study is a study in which catgut, a surgical material that is not modern and is not used in surgery today and can increase adhesion with its reaction, is used. On the other hand, there are studies in the literature showing that closing the peritoneal folds in accordance with surgical techniques in gynecological and obstetric surgeries reduces adhesions<sup>17</sup>. In our study, it was observed that closure of the peritoneum and muscle reduced the formation of adhesions.

Additionally, it was found in a study examining 190 cesarean section cases that the incidence of adhesion increased 8 times in the group in which the peritoneum was not closed<sup>18</sup>. In another study examining 173 cesarean section cases, it was shown that peritoneal closure alone reduced the incidence of adhesion by 5 times<sup>19</sup>. In our study, the incidence of adhesion decreased 8 times in patients whose parietal and visceral peritoneum were closed. In our study, the incidence of adhesion was found to be 2 times lower in the group with only parietal peritoneum closure when compared with the non-closure group.

It was found that the incidence of adhesion was highest in the group (Group 1) where the fascia was closed directly after closure of the uterus. In

addition, it was observed that the rate of Grade 4 adhesion, according to the NAIR classification, was significantly increased in this group ( $p < 0.05$ ). Studies in the literature show that adhesions increase the duration of the cesarean section<sup>20</sup>. In our study, it was shown that the adhesion severity and operation time increased simultaneously, in line with the literature ( $p < 0.05$ ). The increase in adhesions and their severity also increases the risk of intraoperative complications<sup>21,22</sup>.

Major organ injury was observed in two cases with grade 4 adhesion although it was not statistically significant in our study.

Although there are surgical schools in which the parietal peritoneum, visceral peritoneum and muscle layers are closed after the closure of uterus during cesarean section, there are also surgical schools, in which the fascia is closed directly after the closure of uterus. There are also different closing techniques rather than these two methods. The aim of this study is to investigate the effect of postoperative abdominal closure techniques together with modern medical materials and prophylactic drugs on the incidence of adhesion, and to reduce the incidence of adhesion in the light of the findings.

Adhesions after cesarean section increase the operative time and complication rate in the next surgery. A dramatic decrease in the incidence of infections, which is one of the most common causes of postoperative adhesions, has been observed with the advancement in modern medicine. In addition, the use of fast-absorbing suture materials with minimized foreign body reaction is one of the factors that reduces the incidence of adhesion. No matter how good the surgical technique is, it is not possible to completely prevent adhesions. According to the results of our study, closure of visceral, parietal peritoneum and muscle separately reduces the formation of intra-abdominal adhesions after cesarean section.

The incidence of adhesion is more than twice the average incidence of adhesion when none of the layers is closed. Both in the literature and in our study, the incidence of adhesion was found to be 5 to 8 times lower in cases where two layers of the peritoneum were closed compared to non-closure patients. Major organ injury (bowel and bladder) has occurred in only two of 1021 patients included in the study and these two injuries has occurred in the non-closure group. Although the incidence of major organ injury was not statistically significant, the length of the operation time, the incidence of adhesion and the severity of adhesion significantly increased in the non-closure group.



## CONCLUSION

In conclusion, it was found in our study that anatomical closure of the layers during cesarean section statistically reduced adhesion and shortened the subsequent operation time statistically. Although major organ injury was not statistically significant in two patients in whom the anatomical layers were not closed, it can be said that closure of the anatomical layers reduces the risk of major organ injury. Although more comprehensive multicentric studies are needed with modern medicine, we recommend closing the anatomical layers after cesarean section as a result of our study.

## Conflict of interest statement

The authors declare that they have no conflicts of interests.

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