

Influence of Peritoneal Suture on the Formation of Abdominal Adhesions in Wistar Rats: Is Suturing Worthwhile?

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ABSTRACT

Purpose: The purpose of the present study was to determine the effect of peritoneal closure on the formation of abdominal adhesions by verifying their degree of damage on intestinal portions and the omentum with the abdominal wall. Given the different reports found in the literature concerning peritoneal closure mostly in obstetrics and gynecology, any objective information based on statistically tested results may be of great value in the everyday surgery practice.

Material and Method: This is an experimental model on which a laparotomy is performed on the free cavity of the abdominal wall in growing rats. Young *Wistar* rats (approximately 1 month old) were operated through a long median xipho-umbilical abdominal incision. The animals were divided in 3 groups with fifteen rats each: in Group I, only the peritoneum was left open and all the other layers of the abdominal wall were closed; the rats in Group II had their peritoneums closed with unabsorbable cord (Prolene 4-0, Ethicon®). The abdominal wall of the rats in Group III (control) was only opened up to the musculature. The peritoneum, which remained intact and closed, was carefully prodded with the grip of tweezers to avoid lesions and/or perforations in the peritoneum. **Results:** There were no deaths nor incisional dehiscence and/or hernias among the animals. Nine animals of Group I presented adhesions (60%), whereas there were adhesions in all the fifteen animals of Group II (100%). In Group III adhesions were found in two animals (13%). The percentage of adhesions in Group II was significantly higher than those observed in Groups I and III ($p < 0.0001$). Adhesions were mostly formed by the abdominal omentum. It was not observed any effect of the procedure on viscera.

Conclusion: The experimental model that was suggested is appropriate for the establishment and study of peritoneal adhesions. The rate of adhesions found in the **Group II** was significantly higher ($p < 0.0001$) than the rate observed in the **Group I** and **Group III**, suggesting that peritoneum suture can play a important role in the adhesion processes.

Keywords: Abdominal Adherence; Incision Closure; Peritoneal Suture

1. Introduction

The need for peritoneum closure has been discussed for many years. Increase of operative time and formation of abdominal adhesions raise questions concerning the performance of this procedure [1]. Besides being one of the main causes of intestinal obstruction, affecting particularly the small intestine [2], which is related to the type of surgery and the extension of peritoneal damage, adhesions may also affect fertility and cause chronic abdominal pain [3]. Reoperations are more complicated when abdominal adhesions are present, and increase surgery

time and the risk of iatrogenic intestinal lesion. Moreover, the chances are that it may be impossible to perform a laparoscopy on the patient in the future [1].

The ongoing discussion about peritoneal closure has engaged gynecologists, obstetricians and surgeons for years [4,5]. Despite the assertion in several studies that there is no statistical difference between peritoneal closure and non-closure in lower abdominal incisions (caesarean sections) [4,5], some authors have shown significant results in favor of peritoneal non-closure, such as intraoperative time and hospitalization period ($p < 0.01$) [6].

According to McNally and Curtain [7] the incidence of

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adhesions in a group of patients who had their peritoneum closed when they were submitted to caesarean section was 28%, whereas in the group of patients whose peritoneum wasn't closed 14% had adhesions. In the group whose peritoneum remained opened, the operative time was 44.1 minutes, while in the group who had their peritoneum closed the operative time increased to 52.2 minutes ($p = 0.05$) [7].

Weerawetwat *et al.* [8] also described that in women submitted to caesarean section with and without peritoneum closure no statistically significant differences were observed between the groups with regards to complications and adhesions, despite the higher incidence in the group whose peritoneum was closed [8].

Given that there is no consensus in the literature about the need or usefulness of peritoneal suture, the aim of this study is to clarify its effect on the formation of peritoneal adhesions in the abdominal cavity using Wistar rats as the experimental model. In order to observe and analyze the intra-abdominal adhesions on the suture cord, the animals of the three groups were re-operated fourteen days after the first surgery. The three groups were compared with regards to the presence of abdominal adhesion by applying the *chi-square* test for $2 \times N$ tables.

2. Materials and Methods

Forty five 30-day-old Wistar rats weighing between 150 and 200 grams were used in this study. After a 24-hour acclimation in the FCMS/PUC-SP vivarium, the animals were submitted to general anesthesia with a 0.2 - 0.5 ml intraperitoneal injection of Ketamine base -50mg/ml (*Ketalar*[®]-Cristália do Brasil) and Xylazine 10 mg/ml (*Coopazine*[®]-CoopersBrasilLtda) using an insulin needle. Bupivacaine at 0.5% without a vasoconstrictor was injected intramuscularly around the incision which keeps the animal under local anesthesia for up to 2 hours [9].

Sterile surgery fields were set after asepsis procedures with chlorhexidine aqueous solution. After the rats were anesthetized, they were submitted to a median xiphoid-umbilical laparotomy (**Figure 1**). The peritoneum was opened with scissors following the same direction of the wall incision. The intestinal portions were manipulated for 2 - 3 minutes to simulate the surgery manipulation that exposes the peritoneum to the surroundings and dehydration. Subsequently, the peritoneum was closed with an anchor continuous suture made with a cord chosen by the study group:

Group I: composed of 15 rats whose peritoneum remained open, and the other layers of the abdominal wall were closed;

Group II: composed of other 15 rats that had the peritoneum closed with unabsorbable cord (Prolene 4-0, Ethicon[®]).

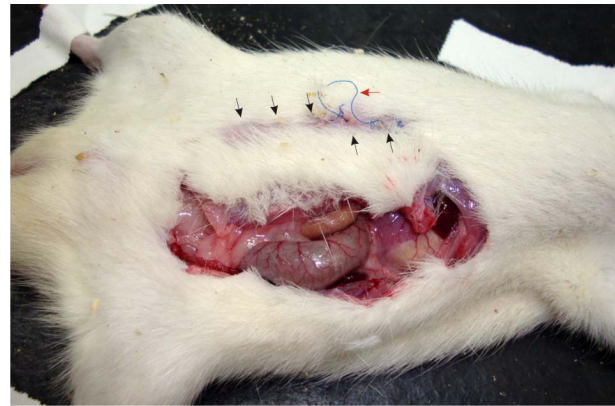


Figure 1. Animal in Group I. Note the primary suture line (black arrows), the median incision cicatrization line (2 weeks later), and Prolene[®] 4-0 cord (red arrow). The second incision was opened to show intestinal portions, it was cut parallel to the previous incision to expose the adhesions.

Group III: represented by 15 rats whose abdominal wall was only opened up to the musculature. The peritoneum, which remained intact and closed, was externally rubbed for approximately 2 - 3 minutes.

Two weeks after the surgical procedure the rats were re-operated to verify if there were adhesions. Another incision was cut parallel to and at about 2 - 3 cm on the left side of the first incision. The entire wall was retracted and examined for the presence of adhesions.

The *chi-square* test for $2 \times N$ [10] was used to statistically compare the three groups with regards to the presence of adhesions.

3. Results

There were no deaths nor incisional dehiscence and/or hernias among the animals. Only one animal of Group II (suture with Prolene[®]) presented intraperitoneal sanguinolent liquid. However, this animal was prostrated and macroscopic hematuria was detected before euthanasia. Macroscopically, the peritoneum of all animals was intact, smooth and shiny.

Nine animals of **Group I** whose peritoneum was not sutured presented adhesions (60%), whereas there were adhesions in all the fifteen animals of **Group II** (100%) that had their peritoneum sutured with Prolene[®]. In **Group III** adhesions were found in two animals (13%) (**Table 1**).

One hundred percent of the animals in **Group II** that had the peritoneum sutured with Prolene[®] presented adhesions when compared with the other two groups, with χ^2 of 23.14. The percentage of adhesions in **Group II** was significantly higher than those observed in **Groups I** and **III** ($p < 0.0001$).

Adhesions were mostly formed by the abdominal omentum. It was not observed any effect of the procedure on viscera (**Figures 2** and **3**).

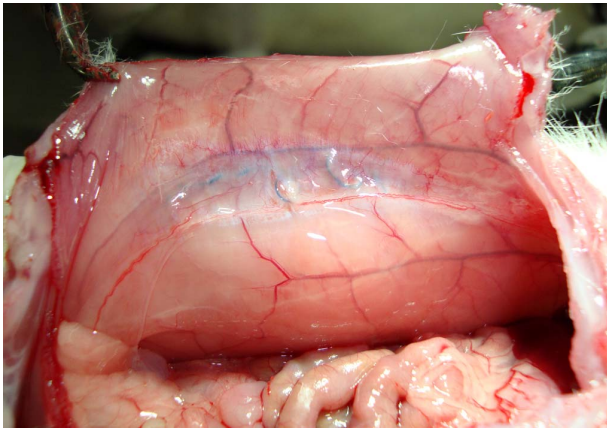


Figure 2. Animal of Group I. The image shows the unsutured peritoneum, only muscular layers of the abdominal wall were sutured. Note Prolene® blue stiches through transparency.

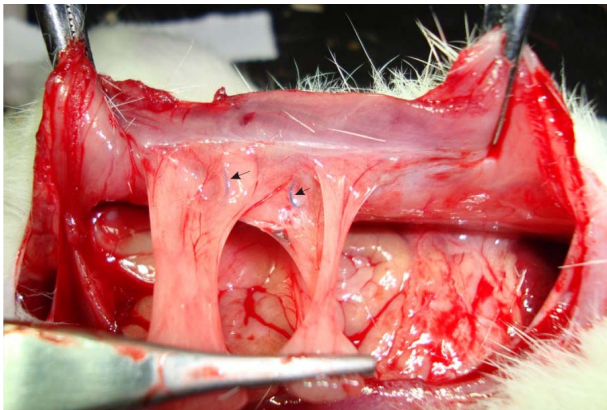


Figure 3. Animal in Group II. Peritonium was sutured with an unabsorbable cord (Prolene®). Note Prolene® blue stichesthroughthetransparency (arrows).

Table 1. Group I is composed of animals whose peritoneum was opened, but was not sutured; the peritonium of the animals in Group II was sutured with Prolene® 4-0 and the peritoneum Group III animals was not opened.

Percentage of adhesions in the 3 groups.				
GROUP	ADHESIONS		TOTAL	% ADHESIONS
	YES	NO		
I (No suture)	9	6	15	60
II (Prolene)	15	0	15	100
III (Control)	2	13	15	13
TOTAL	26	19	45	62

4. Discussion

Having a vast impact on the patients' quality of life and health care costs 1, postoperative adhesions are the main cause of intestinal obstruction and complicated reopera-

tions [1], accounting for more than 40% of all cases and 60% to 70% of those involving the small bowel [2]. Patients submitted to laparotomy have 90% risk of developing intra-peritoneal adhesions and 5% - 20% incidence of re-hospitalization due to adhesion formation [and also with effects on fertility and chronic pain [3].

This is the main reason for the ongoing discussion about peritoneal closure; yet, research is mostly focused on obstetric patients [4,5]. The reconstitution of the abdominal wall anatomy, tissue approximation for better cicatrization, decreased risk of infection by restoring the peritoneal barrier, decreased risk of dehiscence and incisional hernia, and also decreased abdominal adhesions are some of the positive outcomes attributed to peritoneal closure [7,11-13]. On the other hand, faster cicatrization of the abdominal wall and decrease of operative time are described as the advantages of the no-suture approach [7,11,13].

Microscopically, the postoperative peritoneal adhesions were the result of fibrin effusion after a lesion or tissue inflammation with an initial phagocyte wave cleaning up the traumatic debris, and a secondary fibroblast wave healing the lesion and differentiating into new mesothelium cells [14,15]. Most of the fibrotic tissue formed is resorbed within five days. However, in some cases organization with fibroblast and capillary growth may develop, resulting in fibrotic adhesion especially if physiological fibrinolysis doesn't occur in five to seven days [11,12]. The main anatomo-pathological aspect of peritoneal adhesion is the presence of tissue ischemia [11,12], which would be the result of adhesion formation for revascularization of the areas where blood supply was impaired by the surgical act, given that tissue ischemia decreases plasminogen activation [16]. The establishment of adhesion may also occur due to other reasons, such as: trauma, infection, thrombosis and presence of foreign bodies [17]. Other possible risk factors with regards to the development of adhesions include patient's age (under 60 years old), previous laparoscopy in less than five years, peritonitis, multiple laparotomies, emergency surgeries, omental resection and penetrating abdominal trauma, particularly through stab [18].

Nagele *et al.* [19] presented different conclusions and suggest that routine peritoneal closure should be discarded, despite its low morbidity with regards to fever and infection [15,19]. In a prospective randomized study performed by Grundsell *et al.* [6], significant results were found that support the peritoneal non-closure approach concerning intraoperative time and hospitalization period ($p < 0.01$) [6], however, the authors do not mention peritoneal adhesions.

McNally M. *et al.* [7], concluded that closing the peritoneum in caesarean section is not necessary, and that the procedure can even result in adhesion formation [7]. Na-

gele *et al.* [19] also suggested that routine peritoneal closure should be discarded, despite its association with low morbidity related to fever and infection [19].

On the other hand, Cheong *et al.* [4] concluded in an extensive literature review that there are no differences between peritoneal closure and non-closure in lower abdominal incisions with regards to comorbidities such as infections, fever and peritoneal adhesion formation, among others [3]. Weerawetwat *et al.* [8] also described that in women submitted to caesarean section with and without peritoneum closure there are no statistically significant differences, despite their higher incidence in the group whose peritoneum was closed [8].

In the present study, it was observed a higher incidence of peritoneal adhesions in animals whose peritoneum was sutured (**Group II**, 100%) when compared to the group whose peritoneum was not sutured (**Group I**, 60%). These results contrast with Cheong *et al.* [4] conclusion, who asserted that there are no significant differences between suturing and not suturing the peritoneum. The animals in **Group III** (Control group), were only opened up to the musculature and the peritoneum remained intact and had only 13% of adhesions.

The experimental model that was suggested is appropriate for the establishment and study of peritoneal adhesions.

The rate of adhesions found in the **Group II** was significantly higher ($p < 0.0001$) than the rate observed in the **Group I** and **Group III**.

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