

## Induction of intrabdominal adhesion formation by a polypropylene mesh prosthesis: An experimental study in rats

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*INTRODUCTION: The correction of groin hernias using a transperitoneal videolaparoscopic method with a polypropylene mesh is becoming increasingly common. This could lead to an increased incidence of adhesion formation.*

*MATERIALS AND METHODS: The incidence of adhesions induced by mesh placement and by reperitonization was observed in 40 male adult Wistar rats, randomly allocated to four groups of 10 rats (Group A = no mesh, no reperitonization; B = no mesh, reperitonization; C = mesh, no reperitonization; D = mesh and reperitonization). After opening the abdominal cavity, the iliac fossa was identified and a peritoneal opening, measuring about 2 by 2 cm, was done on the parietal wall. In the rats in which a polypropylene prosthesis was used, a piece of Marlex mesh, measuring about 1.5 by 1.5 cm was placed on the peritoneal opening. A simple suture was performed in the animals submitted to reperitonization, using a 5.0 monofilamentar polypropylene thread on a cardiovascular (atraumatic) needle. The animals were killed 15 days after the operation. Macroscopic analysis was done by an investigator blinded to intervention group. Fisher's exact test and the  $\chi^2$  test were used for statistical analysis of the results. A  $P < 0.05$  was considered as significant.*

*RESULTS: Adhesions were significantly more common in the groups in which the prosthesis was placed (59% vs. 95%;  $P = 0.01$ ), as well as in the groups in which reperitonization was performed (58% vs. 100%;  $P = 0.03$ ).*

*CONCLUSIONS: The results suggest that polypropylene mesh placement and reperitonization are each independent factors that have a role in inducing the formation of adhesions.*

*Key-words: Groin hernia; postoperative adhesions; laparoscopic surgery.*

### **Indução de aderência intrabdominal por prótese de retícula de polipropileno: estudo experimental em ratos**

*INTRODUÇÃO: A correção de hérnias na virilha através de um método videolaparoscópico transperitoneal está se tornando cada vez mais comum. Contudo, este método poderia levar a um aumento na incidência de formação de aderências.*

*MATERIAIS E MÉTODOS: A incidência de aderências induzidas pela colocação de*

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retícula e pela reperitonização foram observadas em 40 ratos Wistar adultos, machos, divididos aleatoriamente em quatro grupos com 10 ratos cada um (Grupo A = sem retícula, sem reperitonização; B = sem retícula, com reperitonização; C = com retícula, sem reperitonização; D = retícula e reperitonização). Após a abertura da cavidade abdominal, a fossa ilíaca foi identificada e fez-se uma abertura de aproximadamente 2 x 2 cm na parede parietal. Nos ratos em que uma prótese de polipropileno foi utilizada, uma retícula Marlex com 1,5 x 1,5 cm foi colocada sobre a abertura peritoneal. Nos outros animais, a reperitonização foi feita com sutura simples, utilizando-se fio de polipropileno monofilamentar 5.0 com uma agulha cardiovascular (atraumática). Os animais foram sacrificados 15 dias depois da operação. A análise macroscópica foi realizada por um investigador cego quanto ao grupo de origem dos animais. A análise estatística utilizou o teste exato de Fisher e o  $\chi^2$ . Um  $P < 0,05$  foi considerado significativo.

**RESULTADOS:** As aderências foram significativamente mais comuns nos grupos nos quais a prótese foi utilizada (59% vs. 95%;  $P = 0,01$ ), assim como nos grupos nos quais foi feita a reperitonização (58% vs. 100%;  $P = 0,03$ ).

**CONCLUSÕES:** Os resultados sugerem que a retícula de polipropileno e a reperitonização são fatores independentes entre si quanto à indução de formação de aderências.

*Unitermos:* Hérnia de virilha; adesões pós-operatórias; cirurgia laparoscópica.

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## Introduction

The surgical treatment of groin hernias is one of the most commonly performed surgical procedures in the United States, with over 500.000 surgeries being done yearly. These are, usually, safe procedures, which may be performed on an ambulatorial basis and allowing patients to return to their regular activities in an average of 3 weeks.

With the advent of videolaparoscopic surgical techniques, there has been an excessive number of indications for the correction of groin hernias by this method. To date, the most common technique involves a transperitoneal approach. Many studies have compared the advantages and drawbacks of open versus videolaparoscopic surgery for the correction of inguinal hernias (1-3). Indeed, patient follow-up in these studies is still short, not allowing definitive conclusions in relation to complications and recurrence rate.

One of the arguments against the transperitoneal videolaparoscopic technique is that the placement of a polypropylene prosthesis

(Marlex mesh), in contact with intra-abdominal viscera, could cause the formation of adhesions. In this technique, it is common practice to cover the mesh with peritoneum (reperitonization) after the muscular wall defect has been closed, to avoid contact between the prosthesis and the intrabdominal cavity and to aid on its adequate positioning. Some experimental studies (4-7) have shown that this could lead to an increase in the incidence of adhesions between the mesh and the visceral peritoneum. The association of prosthesis placement and reperitonization, as usually performed on the videolaparoscopic method, could increase even more the occurrence of such complications. The present study was designed to evaluate the incidence of intraperitoneal adhesion formation with the placement of a Marlex mesh, and with reperitonization.

## Materials and methods

Forty male adult Wistar rats, weighing about 250g were studied in the experiment. These were randomly allocated to four groups of

10 rats (A, B, C and D). General anesthesia was induced with inhaled sulfuric ether and maintained with an association of subcutaneous fentanyl and midazolam. Antibiotic prophylaxis was done with a single dose of intramuscular cefazolin (40 mg/Kg), given to the animals immediately before the procedure was started.

The rats were positioned on dorsal decubitus, antisepsis was done with iodated alcohol and a sterile fenestrated surgical dressing were placed on the surgical site.

**Table 1.** Procedures performed according to randomization

Group	Marlex mesh placement	Reperitonization
A	no	no
B	no	yes
C	yes	no
D	yes	yes

A median xipho-pubic incision was performed. After opening the abdominal cavity, the iliac fossa was identified and a peritoneal opening, with about 2 by 2 cm, was done on the parietal wall. Further procedures were performed on each rat according to randomization (Table 1). In the rats in which a polypropylene prosthesis was used, a piece of Marlex mesh, measuring about 1.5 by 1.5 cm, was placed on the peritoneal opening. In the animals submitted to reperitonization, we performed a simple suture, using a 5.0 monofilamentar polypropylene thread with a cardiovascular (atraumatic) needle. The abdominal wall was closed on two planes with continuous suture, using a 3.0 monofilamentar polypropylene.

Fifteen days after the operation the animals were killed with inhaled sulfuric ether on a

**Table 2.** Incidence of adhesions according to randomization group

Adhesions	yes	no
Group A <sup>a</sup>	3	7
Group B	7	0
Group C	8	1
Group D	10	0

<sup>a</sup> $P < 0.05$  compared to the other groups.

supraphysiological dose. Macroscopic analysis was done by an investigator blinded to intervention group.

A specific database was created in Epi-info 6.0 to analyze the data. This was done using Fisher's exact test and the chi-square ( $\chi^2$ ) test. A  $P < 0.05$  was considered as statistically significant.

## Results

There were no deaths during the surgical procedure. Two animals died during anesthesia induction and two died in the immediate post-operative period. Three of the animals which died had been randomized to Group B, and one to Group C. No infectious complications were observed.

Adhesions were present mainly to the omentum, except by two to the bladder and one to the spermatic cord. The incidence of adhesion for each group is shown in Table 2.

The control group had less adhesions than the other groups (A x B  $P = 0.01$ ; A x C  $P = 0.02$ ; A x D  $P = 0.003$ ). Groups B, C and D had no statistical difference in terms of incidence of adhesions (B x C  $P = 1.0$ ; B x D  $P = 1.0$ ; C x D  $P = 0.47$ ).

The animals with a Marlex mesh had more adhesions than the ones without it (A+B x C+D:  $P = 0.01$ ). Reperitonization also increased the incidence of adhesions (A+C x B+D:  $P = 0.03$ ).

## Discussion

Intrabdominal adhesions were rare events before laparotomy became a standard procedure. Papers on surgery from the first half of this century do not mention intraperitoneal adhesions. The penetration into the abdominal cavity brought with it the first descriptions of adhesions (5).

The evolution of surgical procedures showed that in zones of reclosure of open peritoneum, there is a greater incidence of adhesions than in other, non-damaged, zones. Ellis (10,11) says that this is probably due to an obliteration of microvasculature on these areas, producing local ischemia and the development of collateral circulation, thus resulting in adhesion formation.

In relation to the use of the polypropylene prosthesis and its placement in contact with ab-

dominal viscera, the greater concern is regarding the potential complications of the procedure as a whole. Theoretically, complications include intestinal obstructions by adhesions, erosion of abdominal viscera (by contact with the prosthesis) and associated infection. Many authors describe such complications in association with the use of the Marlex mesh to reinforce the abdominal wall, in humans and in experimental studies (8).

The laparoscopic inguinal hernia repair has caused great discussion, due to the need of invading the abdominal cavity and to the routine use of prosthesis. The formation of intraperitoneal adhesions is a rare event with the conventional technique, as opposed to the videolaparoscopic technique, where these complications have been shown to happen, probably due to the factor described above, which, theoretically, increases the chance of adhesion formation (9).

Another important factor for adhesion formation is reperitonization. Durstein-Decker et al. (5) observed a greater incidence of adhesion in rats in which reperitonization was performed to cover an induced abdominal wall defect. This finding could be explained by the theory that closure of peritoneum would produce ischemic areas, thus inducing adhesion formation (10,11). Likewise, laparoscopic repair of inguinal hernias in pigs, using a Marlex mesh, has shown a greater incidence of adhesions in the animals in which reperitonization was performed above the mesh (used in all animal) (9).

In the present study, it was observed that the control group (no prosthesis and no reperitonization) had a lower incidence of adhesion formation than the remaining groups. The animals in which the Marlex mesh was used had a greater incidence of adhesions than the animals without prosthesis. Likewise, the animals on which reperitonization was performed showed a greater incidence of adhesions than their controls. All the animals in the group which underwent prosthesis placement and reperitonization showed adhesions on the 15th day of the experiment.

The results of this study show that reperitonization and polypropylene prosthesis

placement induce intrabdominal adhesion formation.

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