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Role of Fibrin Glue in the Prevention of Peritoneal Adhesions in Ventral Hernia Repair

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Abstract

Purpose. The aim of this study was to investigate the effects of fibrin glue on the prevention of postoperative peritoneal adhesion to prosthetic materials used in ventral hernia repair.

Methods. Ten pigs were included in this study. The abdomens of the animals were opened by means of a median subumbilical laparotomy to place four prostheses that were cut into square pieces of 4×4 cm. The two prostheses in the most cephalic position were polypropylene meshes, and the other two prostheses in a more caudal position were expanded polytetrafluoroethylene prostheses (Dualmesh Plus Corduroy). The prostheses on the right side of each animal were previously impregnated with fibrin glue. After 5 weeks, the animals were reoperated on to assess the quantity and quality (consistency) of the adhesions.

Results. There were fewer intraperitoneal adhesions and they were more labile in the case of prostheses impregnated with fibrin glue. Moreover, we also observed that in many of the animals the polypropylene mesh did not show any adhesions, although polypropylene has been considered to be a typical adhesion producing material.

Conclusions. Fibrin glue reduces both the quantity and consistency of adhesions, even in the case of polypropylene meshes.

Key words Peritoneal adhesions · Fibrin glue · Hernia repair

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Introduction

The use of laparoscopic surgery and its application for the treatment of ventral hernia has produced a change in mentality among surgeons. Before the advent of this technique, surgeons had always avoided the use of foreign body materials in contact with intra-abdominal viscera to avoid the presence of adhesions.

Most procedures for repairing a ventral hernia are associated with the use of intra-abdominal prostheses. This fact has improved the evolution of these materials looking for better in-growth to the anterior abdominal wall, while reducing, at the same time, the amount of possible adhesions, fistulas or other complications as described by Tetik.[1] But the presence of adhesions intraperitoneally is not only produced by the material itself because they have also been related to the surgical technique as it has been demonstrated in other experimental studies (Morales-Conde et al.[2]) that spiral tacks, improperly placed mesh, and leaving the parietal side of these materials exposed to the intra-abdominal viscera could be related to adhesion formation.

We conducted an experimental study to analyze the foreign body response of different materials placed intraperitoneally, expanded polytetrafluoroethylene (e-PTFE) and polypropylene, to determine how adhesion formation, related to the material itself and the surgical technique, could be reduced.

The present study considered the possibility of covering the prosthetic material and the fixation device, tackers, with fibrin glue because this substance has been used in different experimental studies to decrease adhesion formation. In this sense, this material has been used by different authors such us Toosie et al.,[3] De Virgilio et al.,[4] Sheppard et al.,[5] and Chmielewski et al.[6] More recently, Martínez-Ibáñez,[7–8] Nehez et al.,[9] Cohen et al.,[10] Bae et al.,[11] Borrazzo et al.,[12] and Waclawiczek[13] have published similar reports.

Materials and Methods

Ten York pigs (medium weight 35 kg) were included in this experimental study following the European Economic Community directives. The experimental animals were submitted to general anesthesia. Under sterile conditions, an infraumbilical midline incision was performed and four 4 × 4-cm pieces of mesh, two of e-PTFE (DualMesh Plus Corduroy, WL Gore, Flagstaff, AZ, USA), usually used during the laparoscopic approach of ventral hernias, and two of polypropylene (Polypropylene mesh, C.R. Bard, Newark, NJ, USA), as a control group, were place intra-abdominally, being fixed to the peritoneum using four spiral tacks (Protack, USSC, Norwalk, CT, USA) in each corner of each piece of mesh (Fig. 1). Therefore, 40 pieces of meshes ($n = 20$, e-PTFE DualMesh Plus Corduroy; $n = 20$, polypropylene mesh) were implanted in the 10 animals. One e-PTFE and one polypropylene mesh in each one of the animals, those implanted in the right flank of the animal, were covered, together with the spiral tacks, with 2.5 cc of fibrin glue (Tissucol Duo, Baxter, Vienna, Austria), whereas those implanted in the left flank were not covered by fibrin glue, and they were considered to be the control group. Once the prosthetic materials were implanted and the fibrin glue applied, the infraumbilical midline incision was closed.

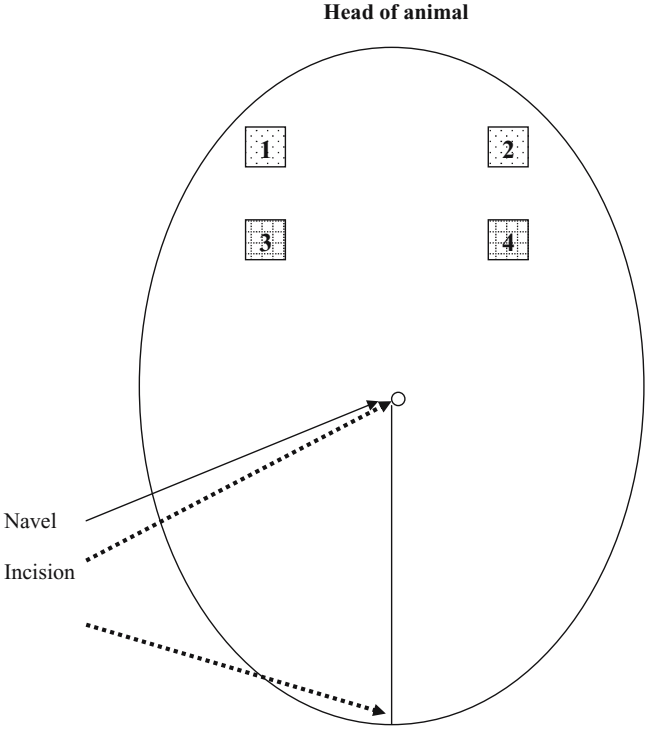

Fig. 1. Prostheses placed in the abdominal wall of the experimental animal. *1*, Polytetrafluoroethylene (PTFE) impregnated with inhibitor; *2*, PTFE without inhibitor; *3*, polypropylene impregnated with inhibitor; *4*, polypropylene without inhibitor

The animals were killed 5 weeks later. A midline incision was performed and the adhesions were evaluated, analyzing the type and the amount of adhesions to the different prosthetic materials and if they were localized to the edges or to the center part of the meshes.

The observer of the adhesions during the second operation was blinded to the initial procedure and the findings were all photographed.

The adhesion level was evaluated according to the same method that Burns et al.[14] previously applied.

The quantity of adhesions was classified by the following scale: 0 — no adhesions, 1 — adhesions covering less than 25% of the surface of the mesh, 2 — adhesions covering between 25% and 50% of the mesh, and 3 — mesh covered by adhesions in more than 50% of the surface. The quality of the adhesions was classified as follows: 0 — no adhesions, 1 — light adhesions that can be freed by pulling, 2 — adhesions that need to be released by blunt dissection, and 3 — firm adhesions only released by sharp instruments.

A statistical analysis was performed using the SPSS 8.0 software program. An analysis of variance was performed followed by *t* tests for independent sample means. The *t* tests for independent sample means can be conducted with or without equal variance assumptions. Levene's test was used that allows the determination as to whether the variances could be assumed to be equal. The null hypothesis was rejected when the *P* value was less than 0.05.

Results

A significant reduction in the quantity and quality of the adhesions was observed in those implanted prostheses covered with fibrin glue. This reduction in the adhesions was mainly observed in the polypropylene mesh (Figs. 2–5).

The medium quantity decreased from 1.2 to 0.5 in the e-PTFE implants; on the other hand, in the polypropylene mesh implants the same values were 2.5 versus 1.3.

The comparative values of quality were 0.9 versus 0.4 in the e-PTFE implants, and 2.1 versus 1.1 in the polypropylene mesh implants.

The area of the prosthetic materials covered by adhesions was different depending on the type of mesh. Whereas the polypropylene mesh adhesions had no special distribution as we observed them over the whole surface, the edges of the e-PTFE mesh showed more adhesions than the central part of the surface (Figs. 6, 7). Those differences were also observed in the mesh covered with fibrin glue.

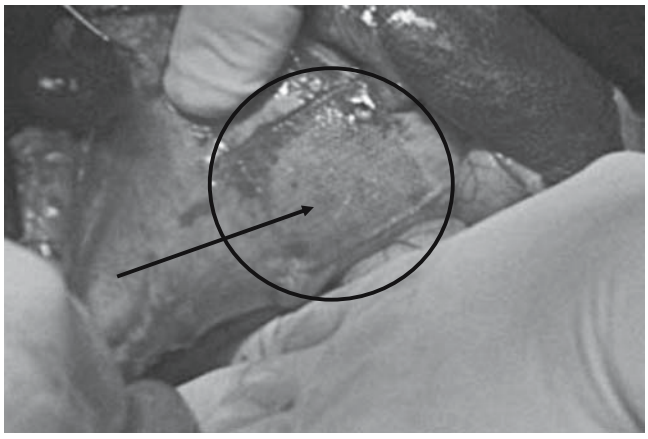

Fig. 2. Polypropylene mesh impregnated with fibrin glue showing no adhesions after 5 weeks

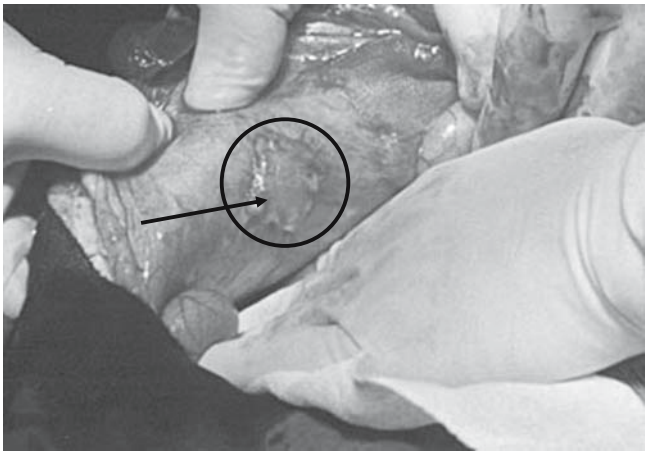

Fig. 3. PTFE prosthesis impregnated with fibrin glue showing no adhesions after 5 weeks

We also observed that all the prostheses became shorter after 5 weeks, especially the e-PTFE implants, which showed a decrease up to 60% of the surface. The use of fibrin glue covering the prosthetic material does not affect this fact (Figs. 8, 9).

Discussion

The ideal material and substances to prevent adhesion formation are still far from being found. Different studies performed so far have shown that it is possible to reduce the quantity and the quality of such adhesions, but none have been shown to prevent them completely.

Different factors are related to the process of adhesion formations, but the need of the bowel and the intraperitoneal organs to isolate any foreign agent (foreign body, bacteria, etc.) seems to play an important role in

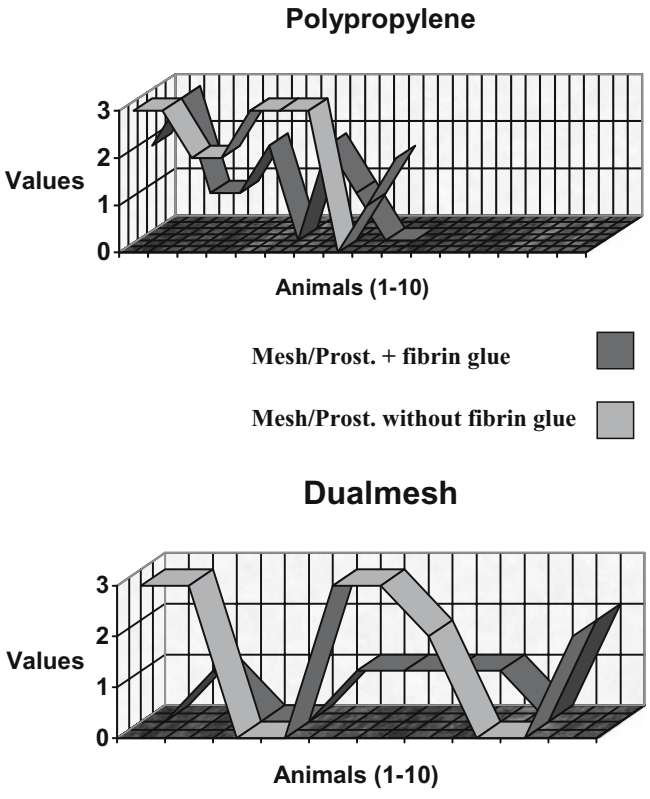

Fig. 4. Comparison of the quality (consistency) of the adhesions covering the prostheses impregnated with fibrin glue and those without the inhibitor substance

this issue. The natural end of this process should in most cases be "restitutio ad integrum".

The reason why this is not always the case is because this healing mechanism has been recently introduced in the phylogenetic scale, and it is closely associated with the presence of the greater omentum, as was demonstrated by Baptista[15] when comparing animals with a resected omentum with others to which such a resection had not been performed.

Laparoscopic surgery has been introduced as a new technique to repair defects of the anterior abdominal wall to avoid the aggressive dissection of tissues needed when performing a conventional open repair because of the necessity of placing prosthetic materials to reduce the high rate of recurrences associated with conventional repair without mesh. This large dissection of tissue is associated with the use of drains, the possibility of contamination and infection of the meshes used, patient discomfort, and long hospital stays. These facts have led surgeons to accept the use of foreign materials, which have always been rejected: by placing a prosthetic material inside the abdominal cavity in contact with the bowel.

This change in the mentality of the surgeons has been followed by a great number of reports studying adhe-

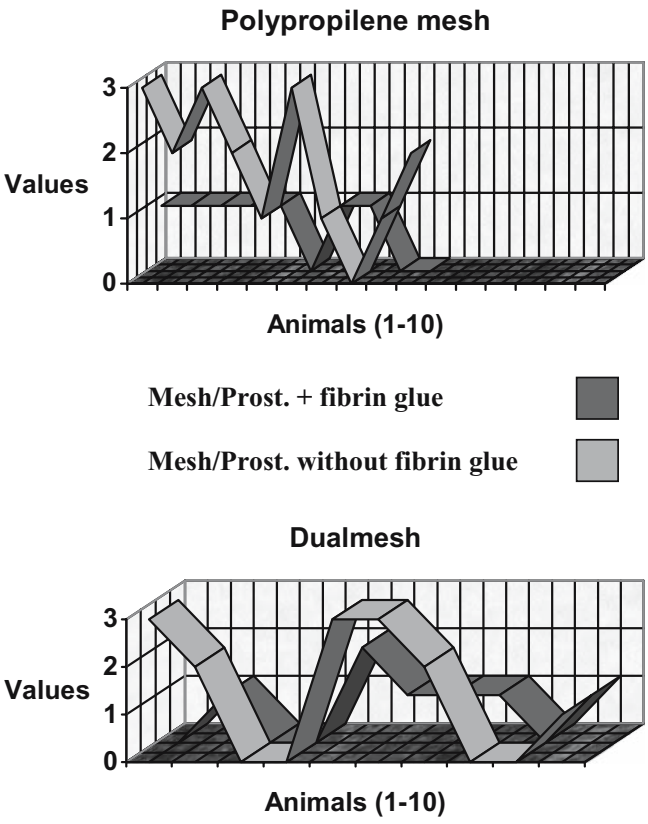

Fig. 5. Comparison of the quantity (amount) of the adhesions covering the prostheses impregnated with fibrin glue and those without the inhibitor substance

Fig. 6. Polypropylene implant surrounded by many peritoneal adhesions (without fibrin glue)

sion formations and the risk associated with the fact of leaving a mesh in contact with intraperitoneal viscera, as well as the differences in the in-growth with different materials in contact with the peritoneum (Baptista,[15] Dabrowiecki,[16] Morales-Conde et al.,[2] Morales-Méndez et al.[17]).

Fig. 7. Firm adhesion fixed to edge of a Dualmesh Plus Corduroy implant, the central area is mesothelialized (without fibrin glue)

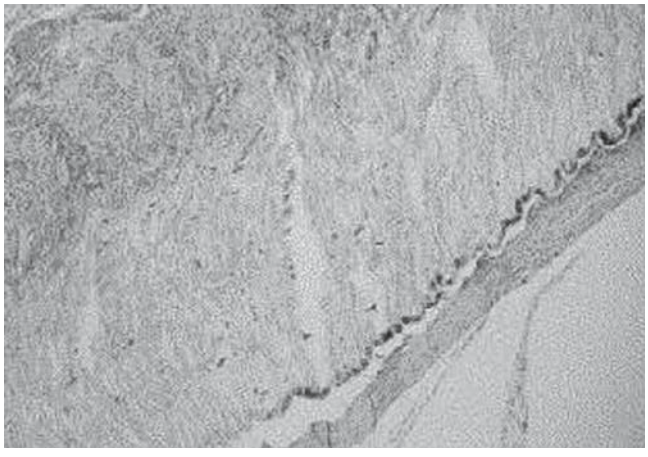

Fig. 8. High-powered magnification (×40) of DualMesh, complete mesothelialization of the visceral surface of the mesh

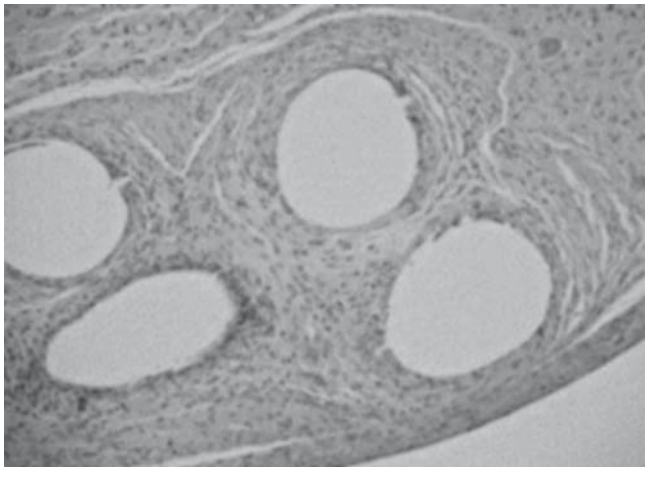

Fig. 9. High-powered magnification (×40) of polypropylene mesh, complete mesothelialization of the visceral surface of the mesh

Different studies conducted by Bellón et al.,[18–21] Kaufman et al.,[22] Liakakos et al.,[23] and Wrijlan et al.[24]) have shown how the porosity of the material is considered to be one of the most important factors related to adhesion formation and in-growth. Large porosity has been related to an increase amount of adhesions. Polypropylene mesh is considered to be a highly porous prosthetic material, which creates important scar tissue involved in adhesion formation. On the other hand, a low porous material, such as e-PTFE (Murphy et al.[25] and Bellón et al.[18–21]), produces a capsule of tissue that covers the mesh with a low rate of adhesions. The ingrowth of e-PTFE is caused by the small size of the interstices of the mesh that only allows its invasion by certain kinds of fibroblasts.

The use of fibrin glue as a barrier of adhesions formation in laparoscopic ventral hernia repair depends on the development of a new laparoscopic applier in antigravitatory position and with a 30°–45° angle. The greater reduction in the number of adhesions covering polypropylene meshes is a result of the greater number of adhesion formations associated with this material. Moreover, Dualmesh Plus Corduroy was designed to produce fewer adhesions. In spite of using a laparotomic approach, in our opinion the results did not change because we were careful not to touch the peritoneal membrane. The edges of the e-PTFE mesh showed more adhesions than the central part of the surface owing to undesired contact with the ridged face of the prosthesis there.

In our opinion, the reduction in the number of adhesions is a consequence of acceleration in the normal process of apposition of fibrin thus giving it priority over the healing one. We are of the opinion that it is necessary to find a sprayer system that can be successfully used with very small pressures to apply this product in a closed abdominal cavity.

Conclusions

We have observed a reduction both in the quantity and more significantly in the quality or consistency of adhesions. No macroscopic alterations were detected in the integration with abdominal wall tissue in relation to the use of fibrin glue.

The formation of adhesions is an extremely complex process, which has not been completely explored so far. As a result, many of the studies on this phenomenon are still empirical, but the results published are so far promising and it is possible that we can control this process in the near future, whether stimulating or inhibiting it, depending on the circumstances. Another consequence of this could be the possibility to use materials for intra-abdominal use in reconstructive surgery of the abdominal wall, which are nowadays avoided because of the great number of adhesions they provoke. Finally, we must mention again the new clinical use of fibrin glue since its use may have great significance from an economic-sanitary point of view.

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