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Evaluation of four mesh fixation methods in an experimental model of ventral hernia repair

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ABSTRACT

Background: The present animal study was conducted to comparably investigate the performance of four different fixation techniques of intraperitoneally implanted meshes.

Materials and methods: Fifteen New Zealand white rabbits were used. In each animal, four abdominal wall defects were created and repaired with four pieces of intraperitoneal mesh (Parietex Composite), fixed with nonabsorbable (titanium) spiral tacks (group A), absorbable (lactic and glycolic acid co-polymer) screw-type tacks (group B), transfascial polypropylene sutures (group C), or fibrin glue (group D). Adhesion formation, mesh shrinkage, tensile strength, and host tissue response were evaluated at 90 d.

Results: Adhesions were observed in all groups, and differences were not significant. The percentage of shrinkage was higher in group C (26.91%), lower in group D (12%), whereas in groups A and B, the mean shrinkage was 20.17% and 23.33%, respectively ($P = 0.032$). The incorporation of mesh fixation element to the abdominal wall was 9.18 ± 3.91 N, 6.96 ± 3.0 N, 13.68 ± 5.38 N, and 2.57 ± 1.29 N, in groups A, B, C, and D, respectively ($P < 0.001$). Regarding local inflammatory response and foreign body reaction, no difference was observed between groups. However, with respect to fibrous tissue presence, its quantity was clearly less in group D compared with the other groups ($P < 0.001$).

Conclusions: None of the examined fixation techniques proved to be ideal. Probably, the best way to fixate an intraperitoneally implanted mesh may be achieved using a combination of the studied materials. Prospective randomized trials are needed to confirm the superiority of the combined use of different fixation devices in clinical practice.

Introduction

Since 1993, when LeBlanc first described incisional hernia repair via a laparoscopic approach, minimally invasive ventral hernia repair has gained extended popularity.[1] The main advantages of laparoscopic hernia repair compared with the open approach include reduced wound complications and a decreased hospital stay.[2] However, in relation to recurrence rate and postoperative pain intensity, the results of published clinical studies and meta-analyses comparing the two surgical

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approaches, open and laparoscopic, have been ambiguous.[3–5] The main causes of hernia recurrence are mesh rupture, mesh slippage, and mesh shrinkage; interestingly, all these factors could be, at least partly, prevented by an appropriate mesh overlap and an appropriate mesh fixation technique.[6,7] Moreover, it is universally accepted that one of the most important reasons for the appearance of chronic postoperative pain is the applied fixation system.[8] Therefore, it is more than obvious that mesh fixation techniques, including transfascial sutures, absorbable and nonabsorbable staples, clips and tacks, and glue, whether biological or artificial, play a crucial and multifactorial role in the effectiveness and safety of laparoscopic ventral hernia repair. Both clinical and animal studies have been conducted to compare different mesh fixation methods in hernia surgery, but the results are inconclusive. Given the fact that ventral hernia repair is one of the most common operations in general surgery and the impact of complications related to mesh fixation systems on the patients' quality of life is undeniable, the design and execution of comparative studies of these fixation methods are considered indispensable. In general, clinical trials produce the more reliable data available for health care decision-making. However, there are operational parameters, such as the tensile strength of the implanted mesh or the applied mesh fixation system, mesh shrinkage, adhesion formation, and host tissue response to the presence of mesh and fixation system, for which clinical studies are not possible to be conducted, both for ethical and for practical reasons. On the other hand, animal studies, if appropriately designed, conducted and analyzed could contribute invaluable information for the aforementioned variables, extend the already existing knowledge and lead clinical practice to more effective and safer ways.

The present animal study was conducted to comparably investigate the performance of four different mesh fixation techniques in respect to adhesion formation, mesh shrinkage, tensile strength, and host tissue response.

Materials and methods

Animals

Fifteen New Zealand white rabbits, with an age of 3.2 ± 0.3 mo and a weight of 2.7 ± 0.3 kg, were used. The animals were housed in individual cages where standard chow and water were available *ad libitum*. The rabbits were acclimatized to their environment for 4 d after their arrival and then fasted for 12 h before the beginning of the procedures. The animal housing environment was kept at a temperature of 21°C with a 12-h light–dark cycle. The study protocol was approved by the Research Committee of the Aristotle University of Thessaloniki. The experiments were performed according to the Animal Research: Reporting of *In Vivo* Experiments guidelines, and all applicable international, national, and institutional guidelines for the care and use of animals were followed.

Experiments

All surgical procedures were conducted under sterile conditions. The introduction to anesthesia was performed with intramuscular injection of ketamin (Ketaset; 35 mg/kg) and xylazine (Xylapan; 5 mg/kg), whereas the maintenance of anesthesia was achieved with intramuscularly administered xylazine when necessary. The animals were allowed to breath spontaneously during the experiment.

All animals were shaved with a clipper, and their abdomen was painted with a 10% povidone–iodine solution. A 10-cm incision was made in the midline, the peritoneal cavity was entered through the linea alba, and the peritoneum was imaginarily divided in four quadrants. In each quadrant, a full-thickness muscular defect (0.5 cm in diameter) was created using a circular die-cutting instrument. Afterward, the defect was closed with 2-0 PDS suture and a piece of Parietex Composite mesh, which is suitable for intraperitoneal placement (multifilament polyester with resorbable collagen oxidized film against the viscera), measuring 3 × 4 cm, was implanted and fixed to the peritoneum over the defect as follows:

- The mesh implanted in the left lower quadrant was fixed with four transfascial 2-0 polypropylene sutures (Prolene; Fig. 1);
- The mesh implanted in the left upper quadrant was fixed with 2 mL (0.5 mL at each corner) fibrin glue (Tisseel), and gentle pressure was applied for at least 5 min to allow bonding between the mesh and the peritoneum (Fig. 1);
- The mesh implanted in the right upper quadrant was fixed with four nonabsorbable (titanium) spiral tacks (ProTack; Fig. 2); and
- The mesh implanted in the right lower quadrant was fixed with four absorbable (screw-type tacks [lactic and glycolic acid co-polymer] AbsorbaTack; Fig. 2).

As a consequence, each animal became a carrier of four different mesh fixation systems and, thus, four groups were created:

- Group A ($n = 15$): mesh fixed with ProTack
- Group B ($n = 15$): mesh fixed with AbsorbaTack
- Group C ($n = 15$): mesh fixed with Prolene sutures
- Group D ($n = 15$): mesh fixed with Tisseel

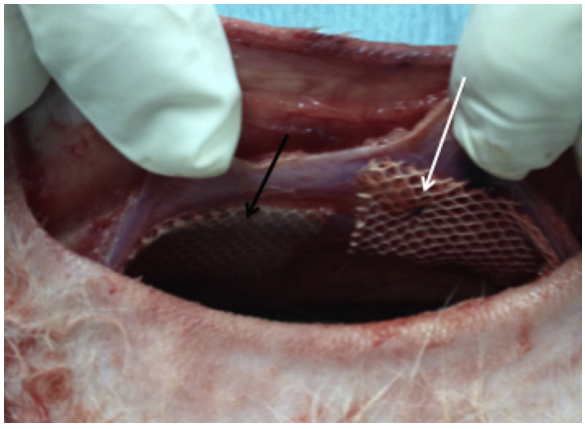

Fig. 1 – Intraoperative picture showing two pieces of mesh intraperitoneally fixed with biologic glue (black arrow) and polypropylene sutures (white arrow). (Color version of the figure is available online.)