

Principles of laparoscopic repair of ventral hernias

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Laparoskopische Technik zur Reparatur von Narbenhernien

Zusammenfassung. *Grundlagen:* Die laparoskopische Reparatur von Narbenhernien, die auf der so genannten intraperitonealen Onlay Mesh-Technik beruht, findet zunehmend Eingang in den klinischen Alltag. Ursache hierfür ist das reduzierte Bauchdeckentrauma im Vergleich mit den offenen Verfahren.

Methodik: Literaturübersicht zur laparoskopischen Behandlung von Narbenhernien.

Ergebnisse: Die aktuelle Literatur zeigt niedrige Rezidiv- und Konversionsraten bei akzeptabler Morbidität im Sinne von unerkannten Darmläsionen. Der entscheidende Vorteil der laparoskopischen gegenüber den offenen Techniken ist die reduzierte Rate an Wundkomplikationen. Die Frage nach dem intraperitoneal zu applizierendem Material, die Gegner der laparoskopischen Reparatur gerne anführen, ist heute geklärt. Verschiedene Netzstrukturen verhindern auf der einen Seite die Ausbildung von Adhäsionen und erlauben eine echte Inkorporation auf der anderen Seite. Eine aktuelle Entwicklung (Polyvinyliden Fluorid) scheint besonders attraktiv, da sie eine Überlappung und damit die Anwendung von mehreren Netzen erlaubt und außerdem eine der originären Bauchwand vergleichbare Elastizität aufweist.

Schlussfolgerungen: Fast alle Narbenhernien können zwar laparoskopisch versorgt werden. Trotzdem ist eine genaue Kenntnis der Hernienkrankheit selbst sowie der verschiedenen Behandlungsoptionen notwendig, um für den individuellen Patienten die jeweils beste Therapie zu finden.

Schlüsselwörter: Bauchwandhernie, Netzimplantation, laparoskopische Technik.

Summary. *Background:* Laparoscopic repair of incisional hernias, which basically means an intraperitoneal onlay mesh technique, is becoming increasingly popular

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as it reduces trauma to the abdominal wall compared with open techniques.

Methods: Review of the literature on laparoscopic repair of incisional hernias.

Results: The recent literature reveals low recurrence and conversion rates with acceptable morbidity in terms of unrecognized enterotomies. The main advantage of the laparoscopic repair over conventional techniques is the reduced rate of wound complications. The question of material often posed by opponents of laparoscopic repair can be answered today. Several materials are available that provide incorporation into the abdominal wall and prevent formation of adhesions to the intestine. A very recent development (polyvinylidene fluoride) seems to be most attractive because of (i) the primary pore size so that 2 meshes can be overlapped, and (ii) elasticity similar to the human abdominal wall.

Conclusions: Although most incisional hernias can be repaired laparoscopically, profound knowledge of the hernia disease itself and different treatment approaches are necessary to provide the best procedure for the individual patient in the sense of tailored surgery.

Key words: Incisional hernia; mesh; laparoscopy; surgical technique.

Introduction

Ventral hernia formation is the most common complication of major abdominal surgery, although almost no series dealing with the outcome of a surgical procedure provides any data on the hernia rate [1–3]. Risk factors for ventral hernia formation have been defined and the suture technique has been improved, but the lowest possible hernia rate seems to be slightly more than 10% [2]. The overall reality, however, may be more than 20% [4–6], rendering repair of ventral hernia a common procedure for general surgeons.

The primary pathogenesis of ventral hernia formation seems to be a kind of connective tissue disease. It has been clearly shown that patients with ventral hernias have abnormal collagen synthesis and collagen disorders, as do patients with aortic aneurysm, who are known to be prone

to hernias [7, 8]. This means that suture of a fascial defect alone must result in a hernia recurrence [9]. There is in fact much evidence that the fascia should be augmented with prosthetic material. The use of mesh does not depend on the size of the hernia [9–12]. A small hernia is based on the same pathogenetic principles as a major one. In other words: each large hernia began small. Furthermore, the repair should include the whole original incision and not only the obvious fascial defect [8], because collagen disease compromises the whole organism and so the whole scar.

Technical aspects of the repair of ventral hernias

The open techniques of ventral hernia repair are mainly based on the separation of the abdominal wall and the placement of a mesh in the retromuscular space or between the subcutaneous tissue and the fascia. The obvious disadvantage of these procedures is the trauma to the abdominal wall, which predisposes to wound complications. The intraperitoneal onlay mesh (IPOM) technique implies wide intraabdominal dissection and the necessity of a particular kind of mesh but without major trauma to the abdominal wall itself except the opening of the original incision. The laparoscopic repair first described in 1993 by Karl LeBlanc is a laparoscopically performed IPOM technique avoiding the separation of the abdominal wall as well as the opening of the original incision but demanding complete intraabdominal adhesiolysis and particular mesh material [13].

Technique of laparoscopic incisional hernia repair

The surgical procedure can be divided in 3 principal steps:

- (i) Access to the abdominal cavity
- (ii) Adhesiolysis
- (iii) Repair of the defect

Although there are numerous variations of the techniques described in the literature some basic principles should be taken into account.

Access to the abdominal cavity

Today the abdomen may be entered via minilaparotomy, using the Veress needle or an optic trocar. Most incisional hernias are associated with intraabdominal adhesions, which can be verified or excluded by ultrasonography. As the specificity of ultrasonography or even MRI, however, does not reach 100% [14, 15], using the Veress needle seems to be the most dangerous approach. The optic trocar also does not entirely prevent enteric lesions. Minilaparotomy should be recommended as the safest technique. Our approach is a minilaparotomy in the lower quadrants in cases of upper or complete midline incisions. For the repair of lower incisions and untouched upper quadrants, we use the Veress needle placed subcostally in the anterior axillary line.

Adhesiolysis

Essentially, the whole anterior abdominal wall must be completely freed of adhesions, especially when there are multiple incisions. One main advantage of the lapar-

oscopic technique is the possibility of defining not only the clinically obvious fascial gap but also the beginning dehiscence of the original incision more or less adjacent to the primary defect. Limited adhesiolysis means losing this advantage! Adhesions near the bowel should be lysed with scissors without any energy source to prevent thermal injury. Only adhesions between the greater omentum and the anterior wall may be severed with electrocautery or an ultrasonic scalpel.

Regions covered with fatty tissue such as the falciform ligament or that between the plicae mediales need to be cleared in order to provide secure fixation of the mesh and not to miss any fascial defects.

Repair of the defect

Unfortunately there is no general agreement on mesh material, fixation or the need to cover the whole original scar. If the hypothesis of incisional hernia as a biochemical disease is accepted, resorbable material should not be used because a stable scar can only be produced with a nonresorbable mesh. The sole use of biologically active structures inducing changes in the scarring process may be a promising approach. As no resorbable mesh is yet available that has been proved to alter collagen metabolism, we will restrict ourselves to nonresorbable materials. Meshes used for the IPOM technique should incorporate themselves into the abdominal wall but prevent adhesions with intraabdominal structures. Polypropylene (PP) and polyester (PE), widely used for sublay or onlay procedures, induce strong adhesions when in direct contact with the intestinal tract and are shown to be associated with infection and fistula [16]. The original “soft tissue patch” from W.L. Gore&Assoc. was replaced in 1994 by an ePTFE-patch with different surfaces called “Dualmesh®”. The rough surface induces scar formation in contact with the abdominal wall, whereas the smooth surface prevents adhesions with the intestinal tract. In the meantime, covered PP and PE meshes have been developed as well as meshes combining polypropylene and ePTFE. In 2002 Thoman clearly recommended only ePTFE for direct contact with viscera [17]. Further reviews of incisional hernia repair also showed that ePTFE was most used for laparoscopic repair [18, 19]. In the meantime, however, some experimental studies revealed inconsistent results [16, 20–25]. Obviously the experimental settings do not exactly reproduce the clinical situation with more or less damage to parietal and visceral peritoneum. Nevertheless, it is clear that pure PP or PE meshes induce the most adhesions as well as clinically obvious complications. The composite prosthesis of PP and ePTFE also seems to be associated with more pronounced adhesions than covered PP or ePTFE [26]. Only for Dualmesh® is there a major report dealing with the extent of adhesions seen during relaparoscopy and demonstrating very promising results [27].

Covered PP or PE meshes represent valuable alternatives. At least the collagen-covered PP and PE meshes are clinically well documented in open and laparoscopic procedures [28–31]. There is much less clinical experience with PP meshes covered with modified cellulose or hyaluronic acid. The main disadvantage of these structures is

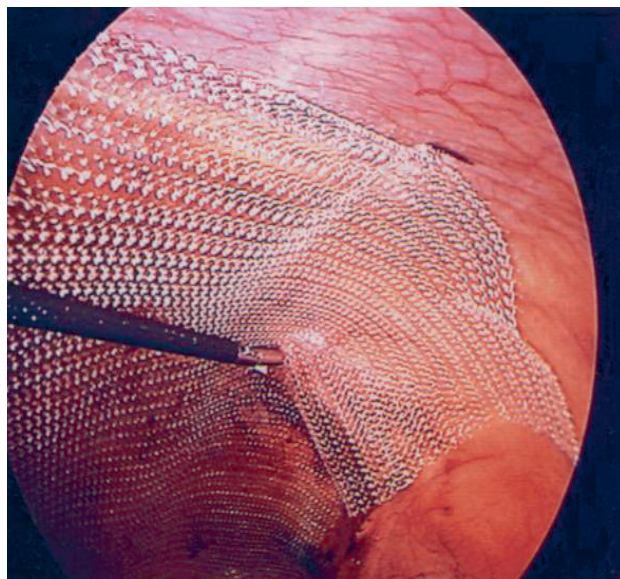


Fig. 1. Intraabdominal view during placement of Dynamesh IPOM[®]

the vulnerability of the visceral layer. So actually a composite mesh consisting of PP and modified cellulose was found to be unstable, with rapid separation of the different layers, and the product was retired. The covering layer of hyaluronic acid and carboxymethyl cellulose may be damaged during implantation in the abdominal cavity. Furthermore, there is no information available to indicate whether incorporation is possible when two meshes overlap each other in cases of complicated hernias.

A very recently developed mesh is made of polyvinylidene fluoride with a small amount of polypropylene on the parietal surface [32]. Dynamesh IPOM[®] (see Fig. 1) is CE registered and has been generally available since October 2004. Experimental data showed fewer adhesions than with the current standard Dualmesh[®], and good incorporation provided by the real mesh structure with a pore size of at least 1 mm. Furthermore, 2 meshes can be placed overlapping each other because the mesh structure enables incorporation of both meshes. Our own experience with more than 600 patients with incisional, umbilical, epigastric and parastomal hernias starting in 1999 comprises ePTFE (Dualmesh[®]), covered PP (Parietene composite[®]) and PVDF (Dynamesh IPOM[®]) see

Table 1. Materials used in our institution

Material	Producer/Distributor
Video equipment	Storz Co., Tuttlingen, FRG
Instruments	Storz Co., Tuttlingen, FRG
Dynamesh IPOM [®]	FEG-Textiltechnik, Aachen, FRG/Dahlhausen Co., Cologne, FRG
Parietene/Parietex Composite [®]	Sofradim Co., Trevoux, France/Tyco Healthcare Germany, Neustadt, FRG
Dualmesh [®]	W.L. Gore & Ass., Flagstaff, USA

table 1. The surgical handling of the elastic PVDF material is comparable to covered PP and better than ePTFE. Postoperative pain and need of analgesics seem to be reduced after implantation of PVDF due to the elasticity of the material, which resembles that of the human abdominal wall. In cases of infection, PVDF (1 patient after repair of parastomal hernia) as well as covered PP meshes (1 patient after umbilical hernia repair) could be saved, whereas in 4 patients who developed secondary infection of an ePTFE mesh after early relaparotomy, the meshes had to be removed.

A last but important question concerns shrinkage of the different materials [33–35]. Up to now only experimental data have shown that these materials all show shrinkage, which was more pronounced when ePTFE was used rather than covered PP or PVDF (unpublished results). That aspect needs to be strictly considered because insufficient overlap of fascial defects will lead to early hernia recurrences.

The area that needs to be covered by the mesh is also a matter of substantial debate. It is generally recommended that an overlap of 3–5 cm over the fascial gap is sufficient [36–39]. However, increasing experience with the laparoscopic technique underlines the necessity of at least 5 cm. The hypothesis of the biochemical nature of hernia disease requires covering the whole original incision. Clinical experience showed the occurrence of new hernias above or below the original repair and supports the idea of covering the whole incision and not only the obvious fascial defect [38, 40].

Fixation of the mesh is the last step in the repair and again involves an unanswered question. Basically, the mesh can be sutured or stapled. In most clinical series both techniques were combined. However, the use of staples only has been shown to have results similar to suturing or the combination of both [19]. It seems to be important to reduce the fatty tissue between mesh and fascia to fix the mesh securely. Therefore the falciform ligament as well as the plicae mediales and the fatty tissue between them must be completely removed.

Results

The recurrence rate is the primary quality criterion of any hernia repair. As recently reviewed by Leblanc [19], recurrence rates range between 0 and 16%. As shown by Cassar in 2002, laparoscopic repair is at least as successful as the open mesh-based techniques [18]. Opponents of laparoscopic repair cite the short follow-up, which only applied to early studies. Today the average follow-up can amount to almost 50 months and is comparable with studies of the open technique [41]. The main advantage over conventional procedures is the reduced rate of wound complications, which was proven in comparative studies [42–48]. Although seromas and hematomas are often seen with ultrasonography, surgical interventions are not necessary unless the patient has severe pain [49, 50].

The overall enterotomy rate ranges between 0 and 6% [19]. A localized enterotomy of the small bowel may be sutured laparoscopically and the hernia repair can be pursued. If the large bowel is injured, the final repair

should not be continued, lest mesh infection occur when ePTFE is used. Due to the increased resistance to infection, the repair can be performed when covered PP or PVDF are used. However, the most challenging complication with laparoscopic repair is the unrecognized enterotomy, which is the main reason for postoperative mortality. Careful surgical technique and avoidance of energy sources will best prevent enterotomies.

The conversion rate is astonishingly low and also supports the feasibility of laparoscopic hernia repair [19]. Furthermore, conversion seems not to be related to postoperative morbidity, as has been shown for colonic surgery [51].

Discussion

As outlined above, some technical details of the laparoscopic repair of incisional hernias are matters of debate. Nevertheless, even with growing popularity and the increasing number of surgeons performing this procedure, the results remain promising when some basic aspects of hernia surgery are considered:

- (i) suitable mesh material
- (ii) broad lateral as well as cranial and caudal overlap
- (iii) covering the whole original incision
- (iv) adequate fixation of the mesh in fascial structures and not in fatty tissue

The limitation of the laparoscopic technique is primarily given by the size of the defect. At least 5 cm of intact fascia must be available laterally between the hernia edge and the trocars to provide sufficient overlap. Roughly, that means that depending on the height of the patient, midline defects measuring more than 15–20 cm in transverse diameter should be better treated by the component separation technique [52]. In our experience large hernias after extended transverse incisions are difficult to repair laparoscopically. But the open approach with subfascial mesh augmentation is even more difficult and may damage nerves in the abdominal wall.

Furthermore laparoscopy cannot be performed if no adhesion-free abdominal wall can be identified, as was responsible for 2 of 6 conversions of our own series. In 2 cases liver cirrhosis with portal hypertension was the reason for conversion due to uncontrollable bleeding GL2. In 2 further patients major enterotomies led to conversion.

Unfortunately the literature does not provide sufficient data to generally define a tailored indication for the repair of incisional hernias as attempted by Dumanian [53].

Our own experience of more than 6 years of laparoscopic incisional hernia repair GL3 leads to the following recommendations:

1. Primary hernias after localized subumbilical midline or flank incisions may be treated by open sublay technique. Each other type of primary and recurrent incisional hernia is a good indication for laparoscopic repair except for very large ones in the midline. In these cases the component separation technique seems to be more suitable.

2. Portal hypertension may be a contraindication for laparoscopic treatment.

3. Using an open access to the abdominal cavity seems to be the safest approach. Only in cases with untouched quadrants may the Veress needle be used.

4. The adhesiolysis should be done without any energy sources. Local bleeding can be safely controlled by bipolar coagulation. The complete abdominal wall should be prepared so as not to miss any defects. Fatty tissue such as the falciform ligament and that between the plicae mediales must be removed. The space of Retzius should be opened in hernias of the lower abdomen, so the mesh can be fixed at the symphysis and the pubic bones.

5. A real mesh structure providing incorporation on one side and preventing adhesions on the other seems to be the material of choice. Since May 2004, we have used only Dynamesh IPOM[®] in more than 200 repairs of incisional, parastomal, umbilical and epigastric hernias without any adverse effects. We always cover the whole original incision and recommend an overlap of at least 5 cm. The mesh is fixed by transfascial stay sutures in the corners and spiral tacks.

6. Secure closure of the port sites is necessary to prevent trocar hernias.

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