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ORIGINAL ARTICLE

Repair of giant incisional abdominal wall hernias using open intraperitoneal mesh

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Abstract
Background Very large and complex incisional hernias, especially those involving loss of abdominal wall, present a particular challenge to the surgeon.
Aims The open intraperitoneal technique was used prospectively for the repair of incisional hernias in a selected group of patients with large defects, often those with major loss of abdominal wall, overweight patients, and previous failures of incisional repair.
Materials and methods Between 1 January 1999 and 31 December 2005, out of 275 patients operated on for incisional hernia repair, 61 of them, most of whom were obese with multiorificial recurrent or giant hernias and contraindicated for laparoscopy, were treated using an open intraperitoneal mesh technique. There were 50 females and 11 males, with a mean age of 61. The median ASA score of the group was 2.3, with a mean BMI of 34 kg/m^2 and a mean hernia surface of 182 cm^2. Sixty-four percent of the patients had undergone one or more previous incisional hernia repairs.
Results Mean operating time was 130 min, with an average hospital stay of 13 days. None of the patients died. Postoperative complications occurred in 21% of the patients; most of which were minor, but two cases (3.3%) developed deep abscesses requiring surgery and removal of the mesh. A recurrence rate of 5% was found after a mean follow-up of 35 months (8–88).
Conclusion Open intraperitoneal mesh repair appears to be a good option for the treatment of complex incisional hernia (at least 10 cm in diameter or multiorificial) in obese patients contraindicated for laparoscopy.

Keywords Giant incisional hernia · Intraperitoneal mesh repair · Open surgery

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Introduction

The repair of ventral hernias remains one of the most common surgical procedures performed by general surgeons [1]. Postoperative ventral hernia occurs in more than 11% of surgical wounds (as shown by long-term follow-up studies [2]).

Obesity, old age, malnutrition, multiple laparotomies, type of incision and closure (including material used), postoperative wound infection, chronic pulmonary disease, and diabetes have been recognized to be risk factors [3]. Abdominal wall defects typically occur within the first five years after surgery, but they may also develop a long time afterwards [4, 5].

Several hernia repair methods have been described. Currently, there is no technique or approach which has become the gold standard for the repair of incisional ventral hernia. This is an even more complex issue when treating obese patients with a massive or multiorificial hernia and loss of abdominal wall [6]. Incisional hernia repair using primary closure techniques such as simple closure or the Mayo procedure is usually performed for small defects less than 5 cm, but it can result in a recurrence rate in excess of 50% [7, 8].

The use of prosthetic mesh has become the standard of care in the management of incisional hernia. The subsequent rate of recurrence has been lowered to 8–24%, but it has not been eliminated [9, 10]. According to Stoppa's rules, the preperitoneal space has long been considered to be the best location for the prosthesis [6, 11]. Also known

as the retromuscular approach, this technique is characterized by the placement of large prosthetic mesh in the space between the abdominal muscles and the peritoneum or the posterior rectus sheath. This technique, which needs a large dissection with in a high incidence of hematoma and seroma formation, is not always feasible, especially in multiorificial defects or in patients with numerous previous operations. Moreover, it requires the use of large subcutaneous flaps and prolonged drainage. Intraperitoneal placement of the mesh is now possible using antiadhesive agents. The ideal mesh stimulates tissue ingrowth from overlying fascia without incurring the development of adhesions at the visceral mesh surface [11, 12].

Composite meshes are double-faced materials that combine the characteristics of macroporous meshes on one hand with the advantages of antiadhesive agents on the other. We used one type of mesh (Composix®, Bard Co., Voisins le Bretonneux, France) prospectively on a group of 61 patients with complex incisional hernia recurrences after previous repair with retromuscular mesh, those with large defects at least 10 cm in diameter, or multiorificials, as well as in patients with contraindicated for laparoscopy.

The purpose of this study is to evaluate open intraperitoneal repair with double-sided mesh for massive incisional hernia, and to determine its impact on hernia recurrence.

Materials and methods

Between 1 January 1999 and 31 December 2005, 275 patients underwent surgery for incisional hernia repair. Sixty-one of them were found to be eligible for repair by open intraperitoneal mesh placement.

Inclusion criteria were: large incisional hernia with a diameter of at least 10 cm, multiorificial defects, recurrence after a previous retromuscular mesh technique, and contraindication for laparoscopy (previous abdominal surgery, cardiorespiratory disease).

The age, gender, body mass index (BMI), previous abdominal operations and hernia repairs, American Society of Anesthesiologists (ASA) score, type and size of mesh, operating time, intraoperative blood loss, length of hospitalization, complications, hernia recurrences, and length of follow-up were recorded for each patient.

Patients were treated intraoperatively by intravenous third-generation cephalosporin. All patients received antithrombotic prophylaxis by low molecular weight heparin.

Any medical or surgical complication that occurred within 30 days of surgery was noted. Recurrence was evaluated by clinical assessment and by examining the patients. When a recurrence was suspected, a CT scan or a sonographic examination was performed. Patients who expressed any concerns about their repair or who reported abdominal discomfort during a telephone follow-up were re-evaluated in the office and often reimaged.

Surgical technique

The procedure used for the repair of incisional hernia is described here. All patients received a mechanical bowel preparation before their operation. All operations were performed under general anesthesia. After skin preparation and draping, the cutaneous scar was excised, the hernial sac was exposed, and the adjacent anterior fascia was cleared of subcutaneous tissue from 3 up to 5 cm from the ring of the hernial sac. The sac was then excised and intestinal adhesions were dissected free. In the abdomen, an adhesiolysis was performed. When possible, interposition of the omentum was routinely performed. A high quality of tissue, muscles, and fascia adjacent to the parietal defect are important for a strong attachment to the mesh. For this reason, the placement of the mesh was at least 6 cm from the edge of the hernia neck. The mesh was secured to the musculo-fascial wall by nonabsorbable sutures through the peritoneum; nonresorbable stitches were spaced about 2 cm apart and placed 1 cm from the border of the mesh to avoid small bowel incarceration. In all cases, the mesh was a bilayer mesh (Composix®) of size 20×30 or 30×30 cm. This nonabsorbable mesh has a polypropylene side, permitting adhesion to the parietal peritoneum, and another side of expanded polytetrafluoroethylene (ePTFE) to suppress adhesion between the viscera and the mesh.

The musculo-aponeurotic edges were closed in the midline to isolate the prosthesis as much as possible from the surgical skin wound, decreasing the risk of infection of the prosthesis in case of superficial suppuration.

Closure of the two edges of the wound should be performed without tension, but this is rarely possible in cases of major incisional hernia. The prosthesis can be covered by a musculo-aponeurotic abdominoplasty. Subcutaneous tissue and skin were closed over four succion drains.

Statistical analysis

Results are stated in terms of mean or median along with their extremes.

Results

The study includes 61 patients. There were 50 (82%) females and 11 (18%) males of mean age of 61 years (range 40–79). Demographic data are reported in Table 1. The median ASA score was 2.3 with a mean BMI of 34 kg/m^2 (range 20–51). All patients had significant comorbidities (Table 2); 13% were heavy smokers. Most of the patients

Table 1 Demographic and perioperative data

Male/female (ratio)	1/4.5
Age (years)	61 (40–79)
Body mass index (kg/m^2)	34 (20–51)
ASA classification[a]	2.3 (1–3)
Patients with failed previous repair (N%)	39 (64)
Defect size (cm^2)	182(120–275)
Mesh size (cm^2)	450 (300–600)
Mesh defect ratio	2.9
Operating time (min)	130 (60–300)
Estimated blood loss (ml)	125 (0–750)
Median postoperative hospital stay (days)	13 (6–70)

Data are expressed as mean values and range

[a] ASA (American Society of Anaesthesiology)

Table 2 Comorbidities: data are expressed as absolute values (percentage)

None	0	0
Obesity (BMI > 30)	42	69%
Morbid obesity (BMI > 40)	12	20%
Diabetes mellitus	12	20%
Arterial hypertension	19	31%
Chronic obstructive pulmonary disease	5	8%
Ischemic heart disease	3	5%
Hypercholesterolemia	10	16%
Heavy smoking	8	13%
Hepatic disease	4	6.5%
Renal insufficiency	3	5%
Alcoholism	7	11%
Thrombophlebitis	5	8%
Arteritis	2	3.3%
AIDS	1	1.6%

were obese: 30 patients (49%) had BMIs between 30 and 40 kg/m^2, and 12 (20%) had BMIs of more than 40. The hernias were all located on the midline and had a mean surface area of 182 cm^2 (range 120–275). The original operation was for umbilical hernia repair in nine cases, gynecological in 18 cases, hepatobiliary in 16 cases, obesity surgery in six cases, and bowel-related lesions in 12. Forty-nine patients (80%) underwent one or more previous repairs. Twenty-four had a first recurrence, 18 a second and seven a third recurrence. In these cases, the last intervention used extraperitoneal mesh 23 times, intraperitoneal three times, and a simple suture for the others.

The mean operating time was 130 min (range 60–300). Three patients had undergone previous placement of an intraperitoneal mesh in other hospitals. The first had numerous adhesions of unknown cause between the bowel and the mesh. In the second case, the bilayer mesh had totally shrunk. The third patient, who underwent a laparoscopic repair with an ePTFE mesh, fixed with Tacker® (Tyco Healthcare, Elancourt, France), had a retraction of the mesh, a seroma and an obstructive syndrome due to the incarceration of the small bowel between the mesh and the muscles. This patient underwent emergency surgery to remove the mesh. Three months later a second operation was performed with an intraperitoneal mesh.

There were no major intraoperative complications (one small bowel injury was sutured without postoperative complications). None of the patients were transfused postoperatively. Oral feeding was resumed after a mean time of 1.6 days. The median hospital stay was 13 days (range 6–70) (ten days after excluding three complications). This length of stay is usual in France in such patients.

There was no mortality. Overall, postoperative complications occurred in 13 patients (21%) (Table 3) and most of them were minor. Of the six cases of wound infection (10%), four needed a skin excision (Table 3). Four of the eight smokers (50%) had wound complications. Two patients (3.2%) presented deep abscesses requiring surgery and the removal of the mesh. One developed a *Staphylococcal* pneumonia.

All of the patients, except one patient who died four months after the operation due to a cerebro-vascular stroke, were reevaluated in 2006. The mean duration of follow-up was 35 months (range 8–88). For 30 patients (50%), the follow-up was greater than two years, and for 15 patients (25%) it was greater than four years.

Two patients had obstructive episodes (eight months, two years), which resolved spontaneously and did not reappear with a mean follow up of two years.

Three patients (5%) developed a recurrent ventral hernia (Table 4). Recurrences occurred at three, six and 24 months. The early recurrence at three months was in a patient with an infected mesh that required removal. The two other recurrences were located at the inferior edge of the initial mesh, and one required bone fixation to the iliac crest during re-repair. CT scan was only performed during the follow-up for cases of obstructive episode (two cases) or suspicion of recurrence (five cases).

Table 3 Postoperative complications following incisional hernia repair: data are expressed as absolute values (percentage)

Medical		
Pneumonia	1	1.6%
Surgical		
Wound abscess	6	10%
Hematoma	3	5%
Seroma	1	1.6%
Deep abscess	2	3.3%

Table 4 Late complications during follow-up: data are expressed as absolute values (percentage)

Prolonged pain after six months (VAS[a] > 3)	2	3.3%
Incomplete small bowel obstruction	2	3.3%
Recurrence	3	5%
Fistula	0	0%

[a] VAS Visual analogic scale

During the follow-up, two patients underwent a colectomy for cancer 14 and 17 months after hernia repair, respectively. In these cases, there were no adhesions between the mesh and the bowel.

Discussion

It is often difficult to resolve the therapeutic problems associated with giant incisional hernias of the abdominal wall. The difficulties arise from the fact that patients are often obese, have a history of several previous operations, and suffer from multiple comorbid conditions [2, 3].

The quality of their abdominal wall musculature is often poor, and sometimes the herniated visceral mass is such that the right of the domicile has been lost. With the chronic nature of some of these hernias, the herniated organs have adapted to their extraabdominal site while the abdominal cavity retracts, enlarging the size of the fibrotic hernial ring. This variety of factors imply a difficult, or even impossible, primary repair [13].

The choice of a technique is more often determined by the surgeon's preference, surgical tradition, or even by the hospital's economical situation, than by the type of incisional hernia [14].

The only indisputable fact is the high rate of recurrence associated with traditional herniorrhaphy without mesh, which can sometimes reach 55% [15].

The use of prosthetic mesh has become a standard of care in the management of incisional hernia [1, 7, 8]. Three options regarding the positioning of the mesh have been evaluated: the premuscular fascial site (onlay technique) [11], the retromuscular fascial site widely used by Rives and Flament (underlay technique) [6, 11], and the intraperitoneal approach (inlay technique), as used by several other surgeons [13, 14, 16–18].

A deep mesh exhibits a higher resistance to the abdominal pressure, as the repair is not beyond but beneath the parietal defect, where the intraabdominal pressure forces the mesh against the wall [19].

However, the main problem with intraperitoneal meshes is the potential risk of visceral lesions [20-22]: adhesions, obstructions, or small bowel fistula formation.

The literature reports that successful results have been achieved with conventional meshes (noncomposite) used intraperitonealy [5, 16, 18, 19], but a longer follow-up is necessary, since obstructions and fistulas may occur several years after mesh implantation [20, 21].

Clinical practice shows that the tendency toward adhesion is low when ePTFE is used [4]. Due to its hydrophobicity and low porosity, this material may form "dead spaces" and consequently seromas and haematomas. Furthermore, the low rate of tissular integration of this material is deemed to be responsible for its lower resistance to traction than the macroporous meshes, which could lead to a recurrence.

To reduce the risk of adhesions, the use of a hydrophobic material with reduced porosity (ePTFE) has been advocated for several years [4]. Nonetheless, the low rate of tissue integration of these meshes is often deemed to be responsible for recurrence. Indeed, it seems difficult to overcome the fact that an implant made from a single material may have both useful and detrimental properties, depending on the tissue with which it is in contact [23]. If the use of this material guarantees no integration into the wall of the viscera, it is not able to provide efficient reinforcement by integrating in the muscular wall. For this reason, meshes with different sides have been proposed: the macroporous side stimulates tissue in-growth from overlying fascia, while the low porosity of the other side reduces the amount of adhesion to the viscera [10].

Composite meshes [11, 24, 25] were introduced in order to get a combination of macroporosity (polypropylene, polyester) and the prevention of adhesion to the bowel (ePTFE, collagen, polyethylene glycol membrane...). This kind of prosthesis is used in laparoscopic approaches [25–27]. De Maria et al. [27] have shown that laparoscopic ventral hernia repair is characterized by less painful recovery and a shorter hospital stay, with 90% of patients treated successfully as outpatients, as compared with 7% in the open group.

The indications for using these meshes in open surgery are: large incisional hernias (more than 10 cm), multirecurrent ventral hernias, and or ventral hernias with associated defects [28]. The intraperitoneal technique does not require dissection of the intermediate layers, which is associated with increased postoperative wound infection. Some authors [13, 20, 22] emphasize the risk of postoperative intestinal occlusion and bowel fistula due to the intraperitoneal location of the mesh. This risk can be avoided by the interposition of the greater omentum whenever possible. Only two medically managed intestinal obstructions were reported in our series.

In our survey, the intraperitoneal positioning of the mesh is indicated not only in cases of giant ventral hernias with loss of abdominal wall and large multirecurrent ventral

hernias, and in cases where associated lesions leading to longer and more difficult operations are present, but also in cases where the laparoscopic approach is contraindicated. The intraperitoneal approach shortens the operating time and reduces the amount of dissection compared to the retromuscular placement of the mesh [29]. The operation is easier, even when performed by less experienced surgeons. There is no unnecessary and extensive subcutaneous and musculo-aponeurotic abdominal wall dissection.

Wound infection is a major complication that is reported to occur in 4–18% of cases after open mesh repair [30]. Considerably lower infection rates have been reported after the application of laparoscopic techniques (0.4%). Antibiotic prophylaxis is recommended with mesh repair.

Recurrence occurs in 30–60% of cases after suture and in 8–24% of cases after mesh repair (5% in our study). Previous clinical studies have shown that incisional hernia, of size >4 cm, results in a higher recurrence rate [1–3].

Mesh infection is a devastating complication of ventral hernia repair. The reduced incidence of mesh infection with the laparoscopic approach, as compared to the open technique, is one of the greatest benefits of the minimally invasive approach. Virtually all cases where the mesh became infected required the removal of the mesh [2].

There were no enterocutaneous fistula. These concerns were not therefore realized, but it is prudent to place the omentum between the small bowel and the mesh during the procedure whenever possible.

Obesity has been established as a risk factor for the development of incisional hernia [22]. Consequently, many candidates for hernial surgery are overweight. Complications of ventral herniorraphy, such as wound infection and recurrence, have also been reported to be more frequent in obese populations [28]. The laparoscopic approach may be better suited to the obese patient due to the smaller wound and theoretically decreased wound complications [31]. Sugerman et al. [22] have reported that severe obesity (BMI $\geq$ 35 kg/m^2) was a greater risk factor for incisional hernia and recurrence than chronic steroid use.

Some studies have shown a statistically significant relation between obesity and a high risk of failure after incisional hernia repair [15]. Sauerland et al. [32] concluded that obesity was the only independent risk factor for recurrence. If the patient follows a preoperative weight loss program, it may be possible to reduce both the tension on the repaired incisional hernia and the technical difficulties encountered by the surgeon.

Conclusion

Introduction of an intraperitoneal large bilayer mesh with two different surfaces via laparotomy is a relatively easy surgical procedure that gives satisfactory results in terms of recurrence (5%) and morbidity (5% major complications), in light of the kind of surgery and the type of patient treated. This technique is especially recommended when there are contraindications for laparoscopic surgery, for obese patients, for patients with multiple previous laparotomies, those presenting with large or multiorificial incisional hernias, and for patients which present a recurrence after the placement of a preperitoneal mesh. It avoids the need for extensive dissection, which is prone to infection. The risk of adhesion, intestinal fistula, or migration of the mesh into a hollow organ seems to be very low in the long term. However, a longer follow-up needs to be performed.

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