

H. Paajanen · H. Laine

Operative treatment of massive ventral hernia using polypropylene mesh: A challenge for surgeon and anesthesiologist

Received: 15 June 2004 / Accepted: 2 August 2004 / Published online: 12 November 2004
© Springer-Verlag 2004

Abstract **Objects.** Surgical repair of very large ventral hernias has become feasible after the introduction of synthetic meshes and developments in intensive-care treatment. In addition to the operative challenges, postoperative disorders in the cardiovascular system, tissue oxygenation, increased intra-abdominal pressure, and pulmonary embolism expose the patient to severe risks. **Methods.** From 1997–2002 we operated on ten patients with giant ventral incisional or umbilical hernia (mean defect size 240 cm²) by using retromuscular polypropylene mesh. All patients were morbidly obese [mean Body Mass Index (BMI) 39 ± 7.2 kg/m²]. Four of the operations were emergencies because of an acute intestinal occlusion, bowel gangrene, and skin complications. The patients were reinvestigated after the mean follow-up of 2.5 years to find out the frequency of recurrence and degree of disability. **Results and Conclusion.** There was no intraoperative mortality, but one patient died at home after 5 weeks because of myocardial infarct and prolonged wound infection. She had mild stable coronary heart disease preoperatively. Although minor wound complications were observed in three patients, there was no need to remove the meshes. One small recurrent hernia was observed in the follow-up, but it was too small to be repaired. The quality of life after surgery was good for all patients, and they were satisfied with the operation. Retromuscular mesh hernioplasty associated with careful patient monitoring in intensive care is safe and feasible in the selected patients with massive ventral hernia.

Keywords Massive ventral hernia · Giant ventral hernia and anesthesia · Mesh · Surgical results

Introduction

Incisional hernias develop in 10–20% of patients after abdominal surgery, and they are a major source of morbidity and recurrence [1]. Small ventral hernias can be repaired by simple sutures, but giant hernias are impossible to operate on without using autogenous tissue flaps or synthetic meshes [1, 2, 3]. Allogenic mesh material has usually been prepared either from polypropylene, polytetrafluoroethylene (ePTFE) or polyglycolic acid [4, 5, 6, 7, 8, 9]. Closure of the complex abdominal hernia is a challenging task [1, 2, 3]. The short-term postoperative disorders include respiratory insufficiency, ischemia of bowel, intra-abdominal compartment syndrome, pulmonary embolism, and skin infections [8]. Although the introduction of synthetic mesh between the ventral abdominal muscles and the posterior rectus sheath seems to have decreased the recurrence rate [4, 9, 10], few studies have focused on the long-term recurrence, pain, and quality of life after the repairing of giant ventral hernias [8]. In the present study, we report on our experience of the surgical viewpoints, problems in the postoperative intensive care, and long-term results of massive ventral hernias operated on by a single surgeon.

Materials and methods

This was a prospective case study during the years 1997–2002 at Mikkeli Central Hospital, Finland. During the study period, we operated on 84 patients with ventral hernias by using polypropylene mesh repair [10]. Ten of these patients had giant hernias with massive depletion of muscular and fascial tissues (Fig. 1). The range of fascial defects varied from 7×7 cm to 25×25 cm (mean size 240 ± 180 cm²). Our technique to repair large ventral hernias has involved the open placement of polypropylene mesh between the rectus muscle and the posterior fascial sheath [10, 11]. One senior consultant surgeon

H. Paajanen (✉) · H. Laine
Department of Surgery and Anesthesiology,
Central Hospital of Mikkeli, Porrassalminkatu 35–37,
50100 Mikkeli, Finland
E-mail: hannu.paajanen@esshp.fi
Tel.: 358 443512220
Fax: 358 15 3512255



Fig. 1 Preoperative and postoperative images of **A** patient number #3 with giant umbilical hernia and skin erosions and **B** patient #10

(HP) operated on nine patients and assisted in one operation. The patients were followed up after 30 ± 19 months (range 7–72 months) to determine the recurrences and wound disorders. Four patients were operated on as emergencies because of bowel occlusion ($n=3$), skin infection and bleeding ($n=1$). The large hernia sac included parts of short bowel ($n=6$), large bowel ($n=6$), greater omentum ($n=4$), and stomach ($n=1$). The necrotic bowel was resected by performing one subtotal colectomy, one right hemicolectomy, and one ileal resection. In emergency cases, 1.5 g cefuroxamine and metronidazole 0.5 g three times per day were administered intravenously for 3–5 days. Thin, poorly

vascularized skin around the hernia sac was carefully excised. The large hernia sac was partially excised, and the rest was carefully closed beneath the mesh. The large and fatty omentum was also resected in most cases to make more space in the abdominal cavity. The mesh reconstruction was based on the open technique popularized by Rives and Stoppa [4, 5]. The medial borders of both atrophic rectus sheaths were incised and the posterior sheath of the rectus dissected up to the edge of the neurovascular pedicle in the semilunar line. Two or more meshes were placed under the rectus muscle but external to the posterior fascia or peritoneum to overlap the defect by 4–5 cm in all directions [10]. The prosthesis was fixed superiorly to the ribs and laterally under the muscle by using six to eight absorbable sutures. Two drains were used for 3 days to evacuate hematomas. To reduce wound infections in nonemergency operations, a

single dose of 2.0 g ceftriaxone was administered intravenously 30 min before the operation. Thromboembolic prophylaxis of low molecular weight heparin was given preoperatively and postoperatively for up to 10 days [10, 11].

The patient characteristics and perioperative data are presented in Table 1 and Table 2. All patients had undergone previous abdominal operations. There were six postoperative midline hernias, three umbilical hernias, and one large parastomal hernia. Wound infection after the primary operation was recorded in three patients. Usually one ($n=7$) or more ($n=3$) 30×30-cm multifilament polypropylene meshes (Premilene, B. Braun AG, Germany) were trimmed and placed between the rectus muscles and underlying fascia. Two patients had large peritoneal defects, and one 15×20-cm Parietex composite graft (Sofradim, France) as well as one 30×30-cm Dexon absorbable mesh (Davis-Geck, USA) were used to close the abdominal cavity. The routine clinical follow-up examinations by the operating physicians were carried out at 1 and 6 months

postoperatively. The long-term results at 30 months were obtained by performing a clinical examination and asking the questions in Table 3.

Results

All the patients with giant hernia were morbidly obese (Table 1). The body mass index was over 40 kg/m² in five patients, between 35 and 40 in two, and between 28 and 35 kg/m² in three patients. The metabolic illnesses associated with obesity are seen in Table 2. All these patients were at high risk during surgical procedures. Essential anaesthesiological data are seen in Table 4. All ten patients had an American Society of Anesthesiologists (ASA) classification of 3. Six patients had combined epidural and general anesthesia, and four had only general anesthesia. Complications during anesthesia

Table 1 Characteristics and intraoperative data of the patients

Females/males	9/1	
Age (mean ± SD)	69 ± 12	
Body mass index (kg/m ² , mean ± SD)	39 ± 7.2	(range 28–52)
Emergency/elective	4/6	
Duration of operation (min, mean ± SD)	120 ± 37	(range 75–190 min)
Operative bleeding (mean ± SD)	580 ± 520	(range 100–2,000 ml)
Stay in hospital (days, mean ± SD)	18 ± 10	(range 7–38)

Table 3 Quality of life after the mean 2.5 years of follow-up

Have you felt pain in the trunk muscles within the last month?	No	9	90%
	Yes	1	10%
If yes, have you taken any pain-relieving pills?	No	8	80%
	Yes	2	20%
Have there been any limitations in work or leisure-time activity?	No	9	90%
	Yes	1	10%
Were there any problems with wound healing?	No	7	70%
	Yes	3	30%
Are you satisfied with the operation?	Yes	9	90%
	No	1	10%

Table 2 Operative techniques and immediate outcome of ten patients with massive ventral hernias. The emergency operation was performed on patients # 1–4

Number	Size of fascial defect	Previous illness	Reasons for giant hernia	First operation	Second operation	Outcome
1	7×7 cm	coronary heart disease	bowel incarceration in parastomal hernia	new colostomy + mesh hernioplasty (Parietex)	no	died (myocardial infarct)
2	20×20 cm	cardiovascular diabetes	multiple deliveries, incarceration of ileum	subtotal colectomy + ileostomy	Rives-Stoppa	excellent
3	20×20 cm	hypertension	umbilical hernia skin infection	Rives-Stoppa operation	no	excellent
4	25×25 cm	none	Hartman's operation colon diverticulitis	Rives-Stoppa operation	no	excellent
5	20×20 cm	cardiovascular diabetes	hysterectomy oophorectomy	Rives-Stoppa operation	wound revisions	excellent
6	15×15 cm	cardiovascular diabetes	cesarean sections umbilical hernia	Rives-Stoppa operation	multiple wound revisions	good
7	10×15 cm	hypertension	cesarean sections	Rives-Stoppa operation	wound revision	good
8	12×12 cm	cardiovascular	cholecystectomy wound infection umbilical hernia	Rives-Stoppa operation	no	excellent
9	7×10 cm	hypertension	cholecystectomy wound infection	Rives-Stoppa operation	no	excellent
10	15×10 cm	hypertension	cesarean section	Rives-Stoppa operation right hemicolectomy	relaparotomy (bleeding)	excellent

Table 4 Essential anesthesiological data of ten patients with massive ventral hernia. The first four patients were operated as emergencies

Patient number	Age	BMI	Anesthesia complications	Epidural analgesia	Days in ICU	Time in respirator	APACHE II
1	74	40	No	Yes	2	< 6 h	23
2	74	34	RR↓	No	1	1 day	18
3	68	45	No	Yes	1	< 6 h	8
4	78	28	RR↓	Yes	No ICU	—	—
5	52	39	RR↓ SaO ₂ ↓	Yes	6	< 6 h	43
6	76	42	No	No	5	No	45
7	58	52	SaO ₂ ↓	Yes	7+2 ^a	1 day	20
8	83	31	No	No	No ICU	—	—
9	77	35	No	No	1	< 6 h	14
10	50	45	SaO ₂ ↓	Yes	3	2 days	26

APACHE II = Acute Physiology And Chronic Health Evaluation; RR↓ = systemic arterial pressure below 80 mmHg over 10 min; SaO₂↓ = oxygen saturation in arterial blood below 90%. BMI = body mass index (kg/m²). ^a = readmission to ICU

were relatively mild, including transient arterial hemoglobin desaturation ($n=3$) and lowering of systemic blood pressure ($n=3$). Treatment of these disorders included administration of etilefrine and routine correcting of ventilatory settings (Table 4).

To ensure careful postoperative monitoring, eight patients were admitted to the intensive care unit (ICU) after surgery. Most patients did not need the extra support of mechanical ventilation, or it lasted only during postanesthesia period (< 6 h) (Table 4). Five patients had mild respiratory failure after surgery, and they were followed up in ICU over 1 day. They needed noninvasive respiratory support and physiotherapy but not intubation or ventilator therapy. The mean Acute Physiology And Chronic Health Evaluation (APACHE II) score was 25 (range 8–45). Two patients had minor arrhythmias and chest pain, and one patient had postoperative pulmonary embolism. Only one patient with severe intra-abdominal bleeding was reoperated on after the primary operation. She recovered well without any other problems.

We had to perform two stomas, which cause evident risk for infectious mesh complications. In the case of the patient with parastomal incarcerated hernia (patient #1, Table 2), the previous sigmoidostoma was removed from the left to right lower abdomen. The Parietex composite mesh was used to reconstruct the fascial defect, but a postoperative wound infection developed, and the patient succumbed after 5 weeks of follow-up. The patient had coronary heart disease prior to surgery, and the reason for death was myocardial infarction, possibly augmented by surgical stress and wound infection. In the second emergency case, no polypropylene mesh was used in the first emergency operation because of the fear of mesh infection. The massive hernia was repaired at the planned second operation after 3 months by using the Rives-Stoppa technique (# 2, Table 2). The third and fourth emergency cases were the patients with skin infection and bleeding as well as intestinal occlusion, respectively. These two patients recovered well after we performed mesh hernioplasty during the first emergency operation (Table 2).

Superficial wound infections were the most frequent late postoperative complications observed in three patients (30%). Nevertheless, none of the meshes had to be removed due to infection.

One small recurrent hernia was found in the follow-up. Prolonged postoperative chronic pain was found in only one patient (10%) (Table 4). Long-term investigation indicated that nine of the patients were free of pain, and two had occasionally used pain-relieving drugs because of chronic abdominal pain (Table 3).

Discussion

Giant ventral hernias typically have massive depletion of muscular and fascial tissues, by complete loss of the anatomical and physiological function of the abdominal wall followed by severe respiratory and visceral involvement [8, 12, 13]. The muscles of the abdominal wall, completely diverted from the midline, are atrophic and may frequently be found near the anterior superior iliac spine. The skin that covers the sac is very thin and poorly vascularized. Infected ulcers, hemorrhages, and skin dermatitis are very frequent (Fig. 1). The peritoneum is usually abundant but may also be missing after multiple previous operations. The volume of the abdominal cavity is chronically contracted and diminished because sometimes the entire bowel has been prolapsed into the hernia sac. All these circumstances technically challenge the operating surgeon and anesthesiologist, and these patients are always at high risk during surgery. Therefore, the indications for surgical treatment must be reserved only for patients with recurrent severe intestinal occlusions and suspicion of bowel gangrene, with major skin lesions associated with repeated hemorrhages or with a substantial loss of quality of life [8].

Our study indicates that properly selected patients with massive ventral hernias can be operated on with acceptable morbidity and mortality by using synthetic mesh hernioplasty and careful postoperative intensive-care support. One of our patients died 5 weeks after the

operation. The patient was already discharged from hospital to the primary nursing home. She had a resistant deep wound infection and coronary heart disease. Autopsy indicated that the reason for death was recently performed surgical treatment associated with myocardial infarct (#1, Table 1). Obviously, the surgical stress and wound infection may have augmented the size of myocardial infarct. Within a massive ventral hernia, one difficult surgical problem is the contracted abdominal cavity. Previous reports have suggested Gore-tex meshes, volume dilatation with saline or air, or omental and bowel resection to solve the problem [8, 14, 15]. Sometimes the surgeon has to do many of these procedures when trying to return the content of the hernia sac into the contracted peritoneal cavity. We have no experience of saline dilution. At least in emergency cases, the resection of bowel and greater omentum is sometimes mandatory and helps the surgeon to close the fascial defect without compromising intra-abdominal pressure. We prefer to use thick polypropylene mesh whenever it is possible (no large peritoneal defect) because most of our patients are morbidly obese, and multifilament mesh gives firm support.

The planned multiple operation strategy is one choice for complicated emergency cases, particularly if bowel infarction and peritonitis is found in the hernia sac. In these cases, extensive bowel resections and stoma reconstruction are sometimes necessary [8, 14]. In the initial operation, the surgeon's goal is to save the patient's life, and only skin is closed. After 2 or 3 months, the giant hernia is repaired by using elective mesh hernioplasty (#2, Table 2). There are many recent studies that suggest that nonabsorbable mesh can be used safely in the presence of an open bowel in the clean contaminated cases [16, 17, 18]. All these studies are, however, retrospective, and there aren't much data to suggest that polypropylene mesh hernioplasty is safe in the emergency operation with prolonged intestinal occlusion and severe peritonitis. These patients are at high risk for increased intra-abdominal pressure after definitive reconstruction of the abdominal wall as well. Intra-abdominal hypertension has been recognized as a source of mortality and morbidity in postlaparotomy trauma patients [19, 20]. Similar abdominal-compartment syndrome can be seen also after repairing a giant ventral hernia. This can be avoided by careful surgical technique, performing extensive resection of the content of the hernia sac, and by using preoperative nasogastric suction drain [8]. During and after the operation, the intra-abdominal pressure can be measured in the intensive care unit via urinary catheter, and if the pressure increases above 25 mmHg, relaparotomy should be considered [20]. This is also our current policy.

Morbid obesity is associated with a substantial reduction in the lung and respiratory functions of a patient, and the operation of massive abdominal hernia is, in theory, an additional risk for these patients. Perioperative and postoperative monitoring of these patients aims to reduce risks and complications. The effect of

obesity on the outcome after ICU admission is unclear and controversial. It is widely believed that the outcome is poor. On the other hand, there are studies indicating that high BMI is not associated with increased mortality in major surgery [20, 21, 22]. In our material, the patients with high BMI tend to stay longer in the ICU, but they needed no extra time on artificial ventilation.

For our patients, previous wound infections and obesity were evident risks for herniation. When thick multifilament mesh was placed into the retromuscular space and properly fixed, the recurrence rate was minimal. We feel that the open technique is more feasible than laparoscopic hernioplasty in massive ventral hernias. Postoperative wound complications can be a source of significant morbidity after open ventral hernia repair. The skin and soft tissue over the hernia are usually thin and poorly vascularized and not optimal for healing. Furthermore, the periumbilical and epigastric perforators, which partially supply blood and nerves to the abdominal wall, are not all preserved when using the open-mesh technique. Fistula formation and infection are potential complications, but in most series, they are below 6% [1]. The wide excision of skin around hernia sac is necessary to minimize problems in wound healing. The long-term pain after mesh placement has not been widely studied after repairing ventral hernias. Recently Martin-Duce and coworkers reported that 42 patients of 152 operated on by open mesh technique suffered from postoperative pain [11]. They reported that all patients had pain up to 3 months after surgery, but after 12 months of surgery, the patients were free of pain [11]. In the present study, almost 90% of the patients were satisfied with the operative result after 3 years. In conclusion, indications for surgery in massive ventral hernias must be strict. Within the properly selected patients with giant ventral hernia, open mesh hernioplasty is relatively safe, and long-term results are acceptable.

Acknowledgements The authors would like to thank Ms. Tammy Hall for revising the manuscript's English.

References

1. Cassar K, Munro A (2002) Surgical treatment of incisional hernia. *Br J Surg* 89:534–545
2. Sukkar SM, Dumanian GA, Szczerba SM, Tellez MG (2001) Challenging abdominal wall defects. *Am J Surg* 181:115–121
3. Mathes SJ, Steinwald PM, Foster RD, Hoffman WY, Anthony JP (2000) Complex abdominal wall reconstruction: A comparison of flap and mesh closure. *Ann Surg* 232:586–596
4. Rives J, Pire JC, Flament JB, Palot JB, Body C (1985) Treatment of large eventrations. New therapeutic indications apropos of 322 cases. *Chirurgie* 111:215–225
5. Stoppa RE (1989) The treatment of complicated groin and incisional hernias. *World J Surg* 13:545–554
6. Temudom T, Siadati M, Sarr MG (1996) Repair of complex giant or recurrent ventral hernias by using tension-free intraparietal prosthetic mesh (Stoppa technique): Lessons learned from our initial experience (fifty patients). *Surgery* 120:738–43
7. McLanahan D, King LT, Weems C, Novotney M, Gibson K (1997) Retrorectus prosthesis mesh repair of midline abdominal hernia. *Am J Surg* 173:445–9

8. Trivellini G, Bagni CM, Sollini A, Senni M, Leone S, Connessini Avesani E (2001) Repair of giant hernias using more prosthesis. *Hernia* 5:124–8
9. Luijendijk RW, Hop WCJ, Van den Tol MP, de Lange DCD, Braaksma MMJ, Ijzermans NM, Boelhouwer RU, de Vries BC, Salu MKM, Wereldsma JCJ, Bruijninckx CMA, Jeekel J (2000) A comparison of suture repair with mesh repair for incisional hernia. *N Engl J Med* 343:392–8
10. Paaianen H, Hermunen H (2004) Long-term pain and recurrence after ventral hernia repair by polypropylene retromuscular mesh: A clinical and magnetic resonance study. *Arch Langenbeck's Surg* (in press)
11. Martin-Duce A, Noquerales F, Villeta R, Hernandez P, Lozano O, Keller J, Granell J (2001) Modifications to Rives technique for midline incisional hernia repair. *Hernia* 5:70–72
12. Bellon JM, Contreras LA, Sabater C, Bujan J (1997) Pathologic and clinical aspects of repair of large incisional hernias after implant of a polytetrafluoroethylene prosthesis. *World J Surg* 21:402–6
13. Pierri A, Munegato G, Carraro L, Zaccaria F, Tiso E, Zotti EF (1995) Hemodynamic alterations during massive incisional hernioplasty. *J Am Coll Surg* 181:299–302
14. Rohr S, Vix J, Kanor M, Meyer C (2000) Treatment of a massive incisional abdominal wall hernia requiring subtotal colectomy using a dual facing mesh. *Hernia* 4:S22–S24
15. Willis S, Schumpelick V (2000) Use of progressive pneumoperitoneum in the repair of giant hernias. *Hernia* 4:105–111
16. Geisler DJ, Reilly JC, Vaughan SG, Glennon EJ, Kondylis PD (2003) Safety and outcome of use of nonabsorbable mesh for repair fascial defects in the presence of open bowel. *Dis Colon Rectum* 46:1118–23
17. Kelly Mem, Behrman SW (2002) The safety and efficacy of prosthetic hernia repair in clean–contaminated and contaminated wounds. *Am Surg* 68:524–8
18. Birolini C, Utiyama EM, Rodrigues AJ Jr, Birolini D (2000) Elective colonic operation and prosthetic repair if incisional hernia: does contamination contraindicate abdominal wall prosthesis use? *J Am Coll Surg* 191:366–72
19. Hong JJ, Cohn SM, Perez JM, Dolich MO, Brown M, McKenney MG (2002) Prospective study of the incidence and outcome of intra–abdominal hypertension and the abdominal compartment syndrome. *Br J Surg* 89:591–6
20. Biffl WL, Moore EE, Burch JM, Offner PJ, Franciose RJ, Johnson JL (2001) Secondary abdominal compartment syndrome is a highly lethal event. *Am J Surg* 182:645–8
21. Reeves BC, Ascione R, Chamberlain MH, Angelini GD (2003) Effect of body mass index on early outcomes in patients undergoing coronary artery bypass surgery. *J Am Coll Cardiol* 20:668–76
22. El-Solh A, Sikka P, Bozkanat E, Jaafar W, Davies J (2001) Morbid obesity in the medical ICU. *Chest* 120:1989–97