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Implantation of Prophylactic Nonabsorbable Intraperitoneal Mesh in Patients With Peritonitis Is Safe and Feasible

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Abstract

Background Patients with peritonitis undergoing emergency laparotomy are at increased risk for postoperative open abdomen and incisional hernia. This study aimed to evaluate the outcome of prophylactic intraperitoneal mesh implantation compared with conventional abdominal wall closure in patients with peritonitis undergoing emergency laparotomy.

Method A matched case-control study was performed. To analyze a high-risk population for incisional hernia formation, only patients with at least two of the following risk factors were included: male sex, body mass index (BMI) >25 kg/m^2, malignant tumor, or previous abdominal incision. In 63 patients with peritonitis, a prophylactic nonabsorbable mesh was implanted intraperitoneally between 2005 and 2010. These patients were compared with 70 patients with the same risk factors and peritonitis undergoing emergency laparotomy over a 1-year period (2008) who underwent conventional abdominal closure without mesh implantation.

Results Demographic parameters, including sex, age, BMI, grade of intraabdominal infection, and operating time were comparable in the two groups. Incidence of surgical site infections (SSIs) was not different between groups (61.9 vs. 60.3 %; $p = 0.603$). Enterocutaneous fistula occurred in three patients in the mesh group (4.8 %) and in two patients in the control group (2.9 %; $p = 0.667$). The incidence of incisional hernia was significantly lower in the mesh group (2/63 patients) than in the control group (20/70 patients) (3.2 vs. 28.6 %; $p < 0.001$).

Conclusions Prophylactic intraperitoneal mesh can be safely implanted in patients with peritonitis. It significantly reduces the incidence of incisional hernia. The incidences of SSI and enterocutaneous fistula formation were similar to those seen with conventional abdominal closure.

Introduction

Patients undergoing emergency surgery for peritonitis are at increased risk of abdominal wall-related complications. The risk of incisional hernia in patients with peritonitis is elevated, with an incidence of up to 54 %, compared with an incidence of 11–26 % in the general surgical population [1–3]. Furthermore, up to 24.1 % of patients with peritonitis undergoing emergency laparotomy may develop fascial dehiscence [4].

Prophylactic mesh implantation has been shown to reduce the incidence of incisional hernia in patients undergoing vascular or bariatric procedures [5–7]. However, it remains unclear if nonabsorbable intraperitoneal mesh implantation in an infected abdominal cavity is safe because of the theoretical increased risk of chronic mesh infection and enterocutaneous fistula [8–10].

In a previous study, we demonstrated the feasibility and safety of nonresorbable intraperitoneal mesh placement in patients with postoperative fascial dehiscence or an open abdomen [11]. The present study aimed to evaluate the safety and feasibility of prophylactic intraperitoneal mesh implantation compared with conventional abdominal wall closure in patients with peritonitis undergoing emergency laparotomy.

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Methods

A matched case–control study was performed. To analyze a high-risk population for incisional hernia formation, only patients with at least two of the following risk factors were included in the study: male sex, body mass index (BMI) >25 kg/m^2, malignant tumor, or previous abdominal incision [12, 13]. Exclusion criteria were no clinical signs of peritonitis, no midline incision, previous laparoscopic surgery, presence of incisional hernia, open abdomen, elective surgery, and previously implanted mesh. Between 2005 and 2010, prophylactic mesh implantation was performed in 63 patients with peritonitis. Patient data were prospectively collected in a database and analyzed retrospectively. In 2008, a total of 401 patients underwent emergency operation at our institution. Among them, 70 patients (17.5 %) underwent conventional abdominal closure without mesh implantation, met the study inclusion and exclusion criteria, and were used as a control group. Clinical long-term follow-up investigations were performed between September and December 2011 at our institution by a single investigator who was not involved in the medical care of the patients. In all, 27 patients (20.3 %) died before the long-term follow-up investigation was performed: 15 patients (23.8 %) in the mesh group and 12 patients (17.1 %) in the control group ($p = 0.391$). Four patients (6.3 %) in the mesh group and four (2.9 %) in the control group were lost to long-term follow-up. If the patients were unwilling or unable to undergo ambulatory consultations at the referral center (16/133; 12 %), their general practitioners completed the clinical examinations and filled out a questionnaire.

Surgical technique

For closure of the abdominal wall in the control group, a standard technique was applied using a running suture of PDS loop (Ethicon Sarl, Neuchatel, Switzerland). The distance of the sutures to the fascial border was 1 cm, and the distance between stitches was ≤1 cm. The total length of the suturing was at least four times the total length of the abdominal incision.

For abdominal wall closure in the mesh group, mesh was implanted intraperitoneally prior to closure. The types of nonabsorbable composite mesh used in 63 patients were as follows: Parietene (Covidien AG, Wollerau, Switzerland) in 45 (71.4 %) patients; Parietex (Covidien AG) in 10 (15.9 %) patients; and Dynamesh (Laubscher, Hölstein, Switzerland) in 8 (12.7 %) patients. Meshes were placed intraperitoneally and fixed with single knot fascial sutures (Prolene 2-0; Ethicon Sarl), endosurgical staples (Protack; Covidien AG), or a combination of the two. Meshes were tailored to overlap lateral and cranial borders of the incision by at least 5 cm. Afterward, the abdominal wall was closed as described for the control group.

The primary outcome measure was incisional hernia. The secondary outcome measures were an open abdomen, surgical site infections (SSIs), enterocutaneous fistula, mesh explantation, and hospital stay. SSIs were assessed up to 30 days after surgery according to the criteria developed by the Centers for Disease Control and Prevention [14]. Infections were categorized as incisional (superficial or deep) or organ–space infections. Superficial SSIs involved only skin and subcutaneous tissue and excluded stitch abscesses. Deep SSIs involved deeper soft tissues, such as fascia and muscle at the site of incision. Organ–space SSIs were defined as infections in any organ or space. Contaminated wounds were defined as acute nonpurulent infections and dirty wounds as having an active infection present. An incisional hernia was defined as any abdominal wall gap with or without a bulge in the area of a postoperative scar that was perceptible or palpable by clinical examination or imaging.

Statistical analysis

Analysis was by intention to treat. Student's t test was performed to determine the significance between continuous variables and Fisher's exact test to compare proportions. The p values were two-sided, and $p < 0.05$ was used as the threshold for statistical significance (NCSS 2007 for Windows; NCSS, Kaysville, UT, USA).

Results

A total of 133 patients with peritonitis who underwent emergency laparotomy fulfilled the inclusion and exclusion criteria. Demographic parameters—including sex, age, BMI, American Society of Anesthesiologists (ASA) score, and co-morbidities—were not significantly different between the two groups (Table 1). No difference was found in the immunosuppression status between the two groups. In the mesh group 11 of the 63 patients (17.5 %) received immunosuppression therapy, as did 9 of the 70 patients (12.9 %) in the control group ($p = 0.51$). There was a significant difference in the sum of risk factors for incisional hernia between the mesh and control groups: median 3 (range 2–4) versus 2 (2–4) ($p = 0.013$) (Table 2).

Table 3 reports the operative results. Grades of intra-abdominal infection (dirty and contaminated) were comparable in the mesh and control groups (58.7/41.3 vs. 54.3/45.7 %; ($p = 0.726$). Operating time and duration of hospital stay were comparable in the two groups. In all, 22 patients (34.9 %) in the mesh group and 17 patients (24.3 %) in the control group were treated on the intensive

Table 1 Demographic parameters

Parameter	Mesh group ($n = 63$)	Control group ($n = 70$)	p*
Age (years)	63 (22–84)	65 (21–90)	0.225**
Male/female	41/22 (65.1/34.9 %)	33/37 (47.1/52.9 %)	0.054
BMI (kg/m^2)	26.5 (16.0–54.3)	25.8 (18.3–60)	0.711**
ASA score	3 (2–5)	4 (2–5)	0.079**
Co-morbidity			
COPD	18 (28.6 %)	12 (17.1 %)	0.147
CHD	24 (38.1 %)	33 (47.1 %)	0.300
Diabetes	13 (20.6 %)	12 (17.1 %)	0.661
30-Day mortality	6 (9.5 %)	5 (7.1 %)	0.756

Results are medians (range) or the number of patients unless otherwise indicated

BMI body mass index, *ASA* american society of anesthesiologists, *COPD* chronic obstructive pulmonary disease, *CHD* coronary heart disease

*Fisher's exact test unless otherwise indicated; **student's t test

Table 2 Risk factors for incisional hernia

Risk factor	Mesh group ($n = 63$)	Control group ($n = 70$)	p*
Male sex	41 (65.1 %)	33 (47.1 %)	0.054
BMI ≥25 kg/m^2	36 (57.1 %)	32 (45.7 %)	0.225
Malignant tumor	28 (44.4 %)	32 (45.7 %)	1.000
Previous laparotomy	58 (92.1 %)	61 (87.1 %)	0.408
Total risk factors (median and range)	3 (2–4)	2 (2–4)	0.013**

*Fisher's exact test unless otherwise indicated; **student's t test

Table 3 Details of operative procedures

Surgical parameter	Mesh group ($n = 63$)	Control group ($n = 70$)	p*
Abdominal cavity			
Dirty	37 (58.7 %)	38 (54.3 %)	0.726
Contaminated	26 (41.3 %)	32 (45.7 %)	0.726
Type of surgery			
Upper GI tract	13 (20.6 %)	13 (18.6 %)	0.829
Lower GI tract	40 (63.5 %)	51 (72.9 %)	0.837
HPB	6 (9.5 %)	3 (4.3 %)	0.307
Other	4 (6.3 %)	3 (4.3 %)	0.307
Operating time (min)	145 (50–665)	180 (60–540)	0.515**
Hospital stay (days)	20 (5–91)	17 (6–194)	0.613**

Results are number of patients or the median (range)

GI gastrointestinal, *HPB* hepatopancreaticobiliary

*Fisher's exact test unless indicated otherwise; **student's t test

care unit postoperatively ($p = 0.188$). In four patients (5.7 %) of the control group, mesh was implanted secondarily during reoperation for an open abdomen.

Table 4 reports outcome parameters. SSIs occurred in 30 patients (60.3 %) in the mesh group and 39 patients (61.9 %) in the control group ($p = 0.603$). The incidence of incisional hernia was significantly lower in the mesh group (2/63 patients) compared with the control group (20/70 patients) (3.2 vs. 28.6 %; $p < 0.001$). Enterocutaneous fistulas developed in three patients (4.8 %) in the mesh group and in two patients (2.9 %) in the control group ($p = 0.667$). One mesh was explanted in the mesh group because of a lack of mesh incorporation secondary to repeated reoperations for postoperative intraabdominal hemorrhage. The 30-day mortality rate for patients with an open abdomen was 20 % (1/5).

Discussion

Prophylactic intraperitoneal mesh implantation significantly reduces the incidence of incisional hernia in patients with peritonitis and is associated with a comparable rate of SSIs and enterocutaneous fistula formation compared to conventional abdominal closure. Abdominal wall-associated complications, such as fascial dehiscence and SSIs, are frequent in patients undergoing surgical therapy for peritonitis. Reinforcement of the abdominal wall with a prophylactic intraperitoneal mesh implantation is a reliable treatment strategy to reduce the incidence of incisional hernia. The present study demonstrates a significantly reduced incidence of incisional hernia in patients with peritonitis undergoing prophylactic intraperitoneal mesh implantation (3.2 vs. 28.6 %; $p = 0.0001$).

Few studies have explored the incidence of incisional hernia. In a retrospective trial, the incidence of incisional hernia was 54.3 % after a median follow-up of 6 years in patients undergoing emergency surgery for secondary peritonitis [1]. A lower incidence of 28.6 % was found in our control group, which may have been due to a shorter

Table 4 Outcome parameters

Parameter	Mesh group ($n = 63$)	Control group ($n = 70$)	p*
SSI	38 (60.3 %)	39 (61.9 %)	0.603
Superficial	21 (55.3 %)	22 (56.4 %)	1.000
Deep	11 (28.9 %)	5 (12.8 %)	0.098
Organ space	6 (15.8 %)	12 (30.8 %)	0.178
Open abdomen	0	5 (7.1 %)	0.060
Enterocutaneous fistula	3 (4.8 %)	2 (2.9 %)	0.667
Incisional hernia	2 (3.2 %)	20 (28.6 %)	<0.001
Reoperation	16 (25.4 %)	22 (31.4 %)	0.565
Follow-up (months)[a]	16 (2–77)	17 (2–48)	0.539**

SSI surgical site infection

*Fisher's exact test unless otherwise indicated; **student's t test

[a] Median and range

duration of follow-up. Prophylactic mesh implantation did not prevent incisional hernia completely in the present study. Incisional hernia was observed in two patients (3.2 %) despite prophylactic mesh implantation. Potential explanations include insufficient mesh fixation or implantation of an undersized mesh. Subgroup analysis showed no difference in the incidence of incisional hernia or SSIs with respect to the different meshes and types of fixation. However, we acknowledge a potential type two error with regard to the small size of the subgroups.

No patient with prophylactic mesh implantation had postoperative open abdomen compared to 5 of 70 patients (7.1 %) in the control group. This difference is not statistically significant.

Complications associated with mesh implantation in patients with peritonitis include SSIs and enterocutaneous fistulas with or without mesh explantation. In the present study, no statistically significant difference regarding the appearance of SSIs was found between patients with and without mesh implantation. No mesh explantations were performed because of chronic infection. SSIs were treated with local therapy, including wound dressing or vacuum-assisted therapy, in both groups.

A relevant difference between this study and previous case series is the mesh material used and the intraperitoneal position of the mesh. Polypropylene-based meshes are associated with significantly reduced ingrowths of bacteria compared to polyester and polytetrafluoroethylene (PTFE)-based meshes [15]. Biofilm produced by gram-positive bacteria provides protection against bacteria only in meshes with large surfaces, such as PTFE, and is thereby associated with chronic infection [15]. The second putative reason for the absence of chronic infection in our series is the mesh placement within the abdominal cavity and not in a preperitoneal space. Unlike preperitoneal tissue, when placed in the abdominal cavity the mesh is in direct contact with peritoneal macrophages and granulocytes, which immediately remove necrotic tissue and initiate a humoral and cellular immune response [16, 17]. In a previous study, mesh implantation in clean-contaminated and contaminated ventral hernia repairs was associated with increased postoperative complications [18]. This study, however, has a selection bias, as the database analyzed did not allow the authors to correct for the indication of mesh implantation [18]. Furthermore, specific mesh-associated complications—e.g., mesh explantation and enterocutaneous fistula—were not described in detail [18].

A limitation of the present study is lack of randomization. Intraperitoneal mesh implantation was performed in selected high-risk patients. Despite being at higher risk, however, the incidence of incisional hernia was reduced in the treatment group at long-term follow-up.

Conclusions

Prophylactic intraperitoneal mesh implantation in patients with peritonitis should be considered as a therapeutic option to reduce significantly the incidence of incisional hernia. The low incidence of enterocutaneous fistula and mesh explantation seems to justify a prophylactic procedure to prevent a frequent complication such as incisional hernia even in patients with an infected abdomen. Randomized, controlled trials are warranted to confirm the safety of prophylactic intraperitoneal mesh placement in the infected abdominal cavity.

Conflict of interest Drs. Anita Kurmann, Corina Barnetta, Daniel Candinas and Guido Beldi have no conflicts of interest or financial ties to disclose.

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