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ORIGINAL ARTICLE

Prevention of parastomal hernia in the emergency setting

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Abstract
Aim This study assessed safety and efficacy associated with hernia prophylaxis using a retromuscular slowly resorbable synthetic mesh for stoma reinforcement.
Method This was a cohort study with a historic reference group. The study took place in a high-volume surgical department. During a 2-year period (July 2012–July 2014), we included 109 patients undergoing emergency surgery with formation of ileostomy or colostomy. All patients received a retromuscular slowly resorbable synthetic mesh (TIGR®, Novus Scientific) at the stoma site. The reference group included 117 patients who underwent emergency stoma formation without a prophylactic mesh in the 2-year period prior to July 2012. The primary endpoint was effect on prevention of parastomal hernia within 1 year. Secondary endpoints were 30-day and 1-year complications including mortality.
Results The operative field was contaminated or dirty in 48% of the procedures. Operative time was significantly longer in the mesh group. The cumulative incidences of parastomal hernia at 1 year for the control and the mesh group were 8 and 7% (p = 0.424), respectively. The postoperative 30-day and 1-year rate of complications, reoperations and mortality were not different between the two groups. No patients underwent removal of the mesh and no clinical mesh infections were seen.
Conclusion Use of a resorbable synthetic mesh during emergency ostomy formation showed no significant preventive effect on formation of parastomal hernia after 1 year. Although surgery was often conducted in a severely contaminated field, the procedure was without significantly increased complication rate.

Keywords Ostomy · Parastomal hernia · Mesh · Complications · Emergency surgery

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Introduction

Parastomal hernia is defined as an incisional hernia in relation to a stoma [1]. Formation of an intestinal stoma is associated with subsequent development of parastomal hernia occurring in up to 50% of the patients [2–4], although not all of these hernias become symptomatic. Treatment of parastomal hernias may include relocation of the stoma, but this procedure involves a 24–80% risk of developing a hernia at the new stoma site [5, 6]. In addition, suture closure of the defect in the abdominal wall at the former stoma site results in an incisional hernia in every third patient [2, 7, 8]. Finally, less than 35% of patients will undergo stoma reversal following creation of a diverting stoma under emergency conditions [9, 10].

Mesh repair of parastomal hernias by open or laparoscopic technique has shown acceptable results with recurrence rates of 0–28 and 4–12%, respectively [11]. Under elective conditions, prophylactic retromuscular placement of a mesh has reduced the incidence of parastomal hernias with an odds ratio of 0.24 reported in a review of Pianka et al., and in other studies of mesh insertion, the incidence is 0–63% with low rates of mesh-related complications including infection [2, 4, 11–17].

There are no studies that exclusively illuminate prophylactic insertion of a peristomal mesh during emergency surgery.

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Single cases in studies of mixed patient categories have demonstrated that patients undergoing emergency stoma formation under severely contaminated conditions may benefit from prophylactic mesh insertion [4, 18–20].

Before this study was commenced, we had the impression that the incidence of parastomal hernia was unacceptably high after emergency stoma formation, substantiated in a report from our national hernia database regarding repair of parastomal hernia showing 34 vs. 8% 20-month reoperation rate in acute vs. elective operation [21]. The colorectal team in our department therefore unanimously decided to introduce peristomal mesh as a prophylactic measure in patients undergoing emergency stoma formation.

We conducted this study to survey the postoperative course after insertion of a prophylactic slowly resorbable synthetic peristomal mesh in an unselected population undergoing emergency abdominal surgery including formation of an intestinal stoma.

Materials and methods

This cohort study took place in a surgical referral centre serving a population of 450,000 in Copenhagen, Denmark. Patients subjected to emergency surgery with formation of an ileostomy or colostomy were candidates for the study. Emergency surgery was defined as surgery commenced within 6 h after the booking procedure. A nurse marked the stoma site before the operation. The reference patient group included patients who underwent emergency formation of a stoma without a prophylactic mesh during the 2-year period from 1 July 2010 to 30 June 2012 (Fig. 1).

The department guideline was changed on 1 July 2012 calling for obligatory use of a prophylactic peristomal mesh in all patients with a life expectancy of more than 3 months, if they underwent intestinal stoma formation as part of an emergency procedure. The surgical staff had access to both an instruction manual and a web-based instruction video demonstrating the technique. In the mesh group, patients were treated with a slowly resorbable synthetic light-weight 7 × 10-cm mesh (TIGR® Matrix Surgical Mesh, Novus Scientific, Uppsala, Sweden). This mesh was made from two types of resorbable fibres: (a) fast-resorbing fibres made of co-polymer of glycolide, lactide and trimethylene carbonate, which retain strength for 1 to 2 weeks and degrade completely within 4 months, and (b) a slow-resorbing co-polymer of lactide and trimethylene carbonate which holds strength until 6–9 months after implantation and is fully disintegrated after 3 years [22, 23]. The mesh was placed on the anterior surface of posterior rectus sheath dorsal to the rectus muscle to reduce the risk of bacterial contamination [24]. This plane was reached through the stoma incision with the same incision size as in the control group. The diameter of the emerging bowel (including 2-lumen with loop stomas) was estimated by the formula: diameter = circumference/π (Fig. 2). After leaving at least 2 cm of overlap on all sides, the mesh was secured onto the posterior rectus sheath with resorbable sutures. The intervention group (mesh group) was thus defined as the patients who underwent emergency stoma formation during the succeeding 2-year period from 1 July 2012 to 1 April 2014.

Preoperative demographic data included age, gender, body mass index, corticosteroid medication, smoking and physical status classification of the American Society of Anaesthesiologists (ASA) score [25]. The indication for emergency surgery, stoma type, degree of intra-abdominal contamination according to the Surgical Wound Classification of the American College of Surgeons [26] and the experience of the operating surgeon were registered.

Data on operative time, postoperative complications including stoma-related events (surgical site infection, intestinal erosion, prolapse and peristomal bulging), reoperations, blood

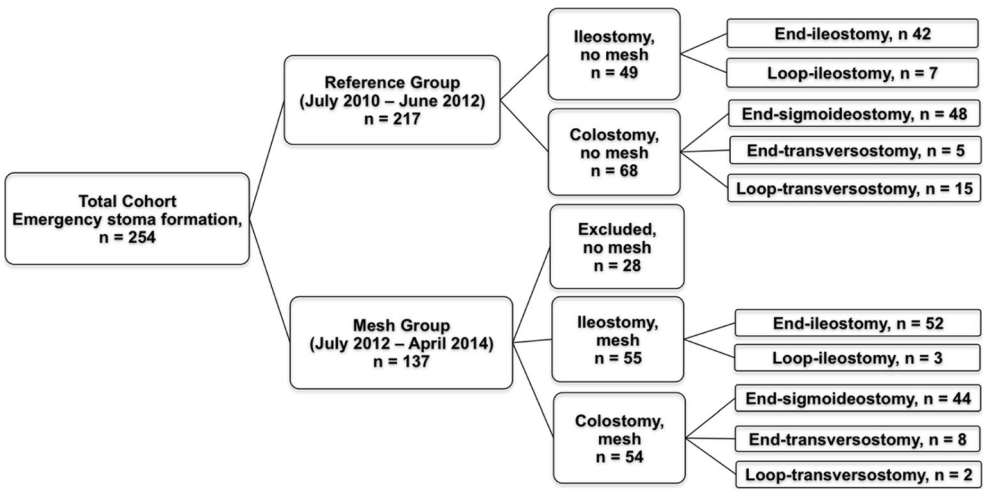

Fig. 1 Consort diagram

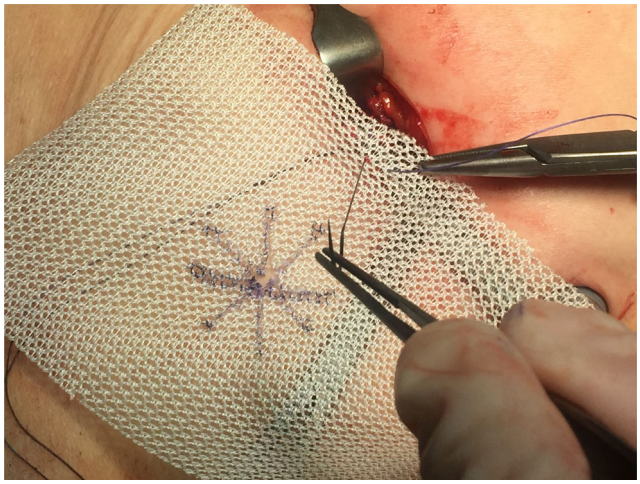

Fig. 2 Mesh before placement demonstrating the triangular flaps creating the stomal aperture

transfusion and mortality were collected at 1, 3, 6 and 12 months according to the planned visits in the ostomy clinic [27]. A trained nurse, who also when in doubt called a colorectal consultant who ordered CT in any case, clinically examined the patients. Abdominal CAT scan under Valsalva's manoeuvre for the diagnosis of a parastomal hernia was performed in patients with both clinical documentation of a peristomal bulge or sensation of bulge by a radiologist blinded to mesh insertion.

The primary endpoint was the cumulative 1-year incidence of parastomal hernia as verified by CAT scan. Secondary endpoints were 30-day complications including stoma-related adverse events. For all patients, a search in our electronic database covering all local adjacent hospitals was performed to ensure that no admission or treatment was missed.

The Mann-Whitney *U* test for numeric variables and the chi-squared test, Fisher's exact test or the Cochrane-Armitage test for trend for qualitative data were used for comparison between the two cohorts. Time-dependent data were analysed with the log rank test. The level of statistical significance was 0.05. Statistical analysis was performed using IBM SPSS® Statistics version 22 (Armonk, NY, USA).

Results

The reference group consisted of 117 patients undergoing emergency stoma formation without insertion of a prophylactic mesh (Fig. 1). One-hundred and thirty-seven patients underwent emergency surgery with formation of a stoma after change of the guideline (mesh group). In this group, a prophylactic mesh was inserted at the stoma site in 109 patients (80%). A total of 28 patients did not receive a prophylactic mesh. In two of these patients, it was technically impossible to place the mesh due to fibrosis of the retromuscular space.

Table 1 Demography and perioperative data

	Reference group (n = 117)	Mesh group (n = 109)	p
Gender			0.54
Male	51 (44%)	52 (48%)	
Female	66 (65%)	57 (52%)	
Age (years)*	72 (63–80)	72 (65–78)	0.98
Body mass index (kg/m^2)*	24.0 (20–28)	24.2 (21–28)	0.85
ASA			0.67
1	11 (9%)	15 (14%)	
2	75 (65%)	67 (62%)	
3	30 (26%)	25 (23%)	
4	1 (1%)	2 (2%)	
Smoking			0.28
Yes	28 (24%)	30 (28%)	
No	46 (39%)	34 (31%)	
Former	18 (15%)	26 (24%)	
Missing	25 (21%)	19 (17%)	
Immunosuppresive treatment			0.07
Corticosteroids, systemic	10 (9%)	5 (5%)	
Chemotherapy	0	2 (2%)	
None	107 (91%)	102 (94%)	
Operation time (minutes)*	151 (101–213)	188 (131–241)	0.0005
Surgeon skill level			0.97
Consultant	61 (52%)	54 (50%)	
Senior surgeon	50 (43%)	50 (46%)	
Supervised surgeon	5 (4%)	4 (4%)	
Missing	1 (1%)	1 (1%)	
Indication for surgery			0.42
Intestinal obstruction	40 (34%)	41 (37%)	
Benign	22 (19%)	19 (17%)	
Malignant	18 (15%)	22 (20%)	
Intestinal perforation	36 (30%)	25 (23%)	
Benign	32 (27%)	23 (21%)	
Malignant	4 (3%)	2 (2%)	
Anastomotic leakage	21 (18%)	22 (20%)	
Intestinal ischemia	7 (6%)	12 (11%)	
Colitis	8 (7%)	5 (5%)	
Stoma malfunction	4 (3%)	4 (4%)	
Necrosis of stoma	3 (3%)		
Incarcerated parastomal hernia		1 (1%)	
Iatrogenic bowel perforation		1 (1%)	
Stenosis		1 (1%)	
Separation of stoma		1 (1%)	
Torsion of stoma bowel	1 (1%)		
Necrotising fasciitis	1 (1%)		
Peritoneal contamination			0.27
None or ascites	63 (54%)	53 (49%)	
Pus	26 (22%)	22 (20%)	
Faeces	28 (24%)	34 (31%)	
Perioperative blood transfusion	54 (46%)	54 (50%)	0.61
Length of stay (days)*	12 (8–24)	14 (7–29)	0.76

* Values are medians (interquartile range)

There was no documented reason why the remaining 26 patients did not receive a prophylactic mesh. The 3-month

Table 2 Cumulative numbers of events within 1 year postoperatively

	Reference group (n = 117)	Mesh group (n = 109)	p
Death	47	46	0.79
Reversal of stoma	23	16	0.38
Relocation of stoma	2	4	0.43
Emigration	5	1	0.21
Peristomal bulging	16	18	0.58
Parastomal hernia, verified	9	8	0.42

mortality rate of these 26 patients was 42% as compared with 21% in the reference group.

The two patient cohorts were comparable with regard to demographic and perioperative characteristics (Table 1). However, median operative time was 37 min shorter in the reference group compared with the mesh group, $p < 0.0005$. Length of stay showed no significant difference between the groups.

At 1-year postoperative, there were no statistically significant differences between the groups as regards the cumulative rates of CAT-verified parastomal hernia, peristomal bulging, prolapse, stoma reversal and mortality (Table 2 and Fig. 3). No perioperative difficulties were encountered during the stoma reversal procedures. Beside emigration, no patients were lost in follow-up. No clinical mesh infections were reported, and no patients in the mesh group underwent surgical removal of the mesh.

There was no statistical significant difference between the groups in the 30-day cumulated incidences of complications, reoperation or mortality; except for a lower rate of perioperative septicaemia in the reference group (29%) than in the mesh group (43%), $p = 0.03$ (Table 3).

Seven percent in the reference group and 9% of the patients in the mesh group developed a stomal complication within 30 days. Six percent in both groups underwent at least one reoperation for a stomal complication within 30 days (Table 4). One patient in the reference group underwent two stoma-related reoperations. In the mesh group, one patient underwent reintervention on postoperative day 10 for intestinal obstruction due to adhesions between the small bowel and a part of the mesh that partly protruded intraperitoneally. After release of the adhesions, peritoneum was adapted to cover the mesh that was left in situ, and the patient experienced no further complications. Two patients in the mesh group developed perforation of the ostomy bowel to the subcutaneous tissue within 30 days postoperative. One of these patients had received several enemas in the stoma via a rectal tube. The stoma was relocated placing a mesh at the new stoma site. In the second case, the intestinal perforation was adjacent to the implanted mesh. The patient underwent local revision of the ostomy using the same stoma site.

With respect to stoma-related complications during the period between 1 and 12 months postoperatively, no inter-group differences were seen (Table 4). One patient in the mesh group experienced a superficial peristomal infection not requiring reoperation. Three of the patients in the reference group and one patient in the mesh group underwent a reoperation due to stoma-related complications (Table 4). The patient in the mesh group underwent relocation of the ostomy at postoperative day 271 due to iatrogenic perforation of the stoma bowel after self-irrigation.

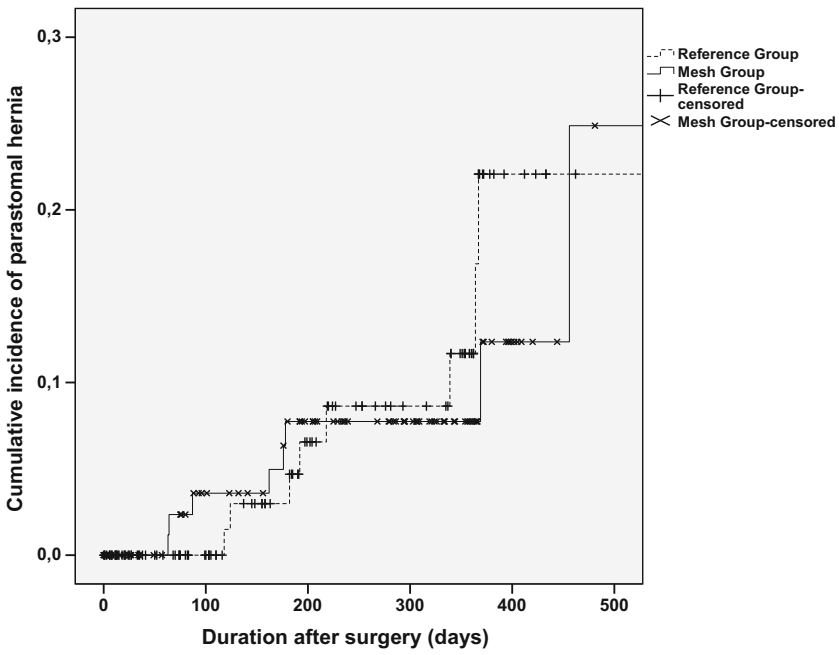

Fig. 3 Cumulative incidence of parastomal hernia vs. time after emergency stoma formation

Table 3 Cumulative rates of 30-day events

	Reference group (n = 117)	Mesh group (n = 109)	p
Complications requiring reoperation[a]	24 (21%)	25 (23%)	0.66
Burst abdomen	10 (9%)	6 (6%)	
Stoma related	7 (6%)	6 (6%)	
Bowel obstruction	4 (3%)	5 (5%)	
Intra-abdominal abscess	3 (3%)	2 (2%)	
Bowel perforation/necrosis	2 (2%)	6 (6%)	
Gastric ulcer perforation		1 (1%)	
Anastomotic leakage	1 (1%)		
Other complications[a]	68 (58%)	72 (66%)	0.22
Sepsis	34 (29%)	47 (43%)	
Respiratory	22 (19%)	26 (24%)	
Surgical site infection	18 (15%)	23 (21%)	
Cardiovascular	10 (9%)	9 (8%)	
Urogenital	6 (5%)	8 (7%)	
Stroke (cerebral)	4 (3%)	1 (1%)	
Short bowel syndrome	2 (2%)	3 (3%)	
Superficial stoma infection	1 (1%)	3 (3%)	
Gastrointestinal bleeding		4 (4%)	
Other	5 (4%)	6 (6%)	
Clavien-Dindo classification			0.13
1	33 (28%)	26 (24%)	
2	22 (19%)	16 (15%)	
3	15 (13%)	8 (7%)	
4	28 (24%)	43 (39%)	
5	19 (16%)	16 (15%)	
Mortality	19 (16%)	16 (15%)	0.75
Sepsis	13 (11%)	14 (13%)	
Respiratory	4 (3%)		
Stroke (cerebral)	1 (1%)		
Malignancy	1 (1%)	1 (1%)	
Missing		1 (1%)	

[a] Number of patients with at least one complication

Table 4 Cumulative rates of stoma-related complications

	Reference group (n = 117)	Mesh group (n = 109)
Superficial infection without reoperation within 30 days	1 (1%)	3 (3%)
Complications requiring reoperation within 30 days	7 (6%)	6 (6%)
Necrosis of ostomy bowel	5 (5%)	2 (2%)
Intra-abdominal abscess	–	1 (1%)
Stoma prolapsed	1 (1%)	–
Stoma obstruction	1 (1%)	1 (1%)
Stoma subcutaneous perforation	–	2 (2%)
Superficial infection without reoperation within 1–12 months	–	1 (1%)
Complications requiring reoperation within 1–12 months	3 (3%)	1 (1%)
Stoma dysfunction	3 (3%)	–
Iatrogenic perforation of stoma bowel	–	1 (1%)

Discussion

This study comprehends unselected patients undergoing emergency general surgery stoma formation in combination with peristomal implantation of a retromuscular prophylactic synthetic mesh. Although operative time was prolonged, we found that use of a slowly resorbable light-weight mesh during emergency ostomy formation did not increase the complication rate, even when surgery was conducted in a dirty field. However, as compared with a historic cohort, we found no reduction in the 1-year incidence of parastomal herniation. Therefore, we cannot recommend use of mesh on the basis of the present results from acute ostomy creation. As a consequence, we have abandoned this procedure, as it is expensive in time and cost.

The incidence of parastomal hernia increases over time up to 20 years after the index operation [28]. Very different hernia rates are previously reported [29]. In the present study, the cumulative 1-year hernia incidences were 8% in the reference group and 7% in the mesh group. These low frequencies may predominantly be explained by the 42% mortality rate and 15% stoma reversal rate within the first year.

It remains unclear if emergency surgery increases the risk of parastomal herniation [28–30]. The initial size of the aperture may be a risk factor. It is possible that the aperture in the peristomal mesh was created too wide in the presence of a temporarily distended and oedematous bowel [28–31]. Moreover, it remains unknown if the present results recorded in groups of patients with low prevalence of obesity are valid amongst obese patients with a higher risk of parastomal hernia formation [17, 32].

We found no significant differences in complication rates between the two groups, except for the increased rate of septicaemia within the first 30 days postoperative in the mesh group. A recent retrospective cohort study by Sheetz et al. included 4250 patients undergoing elective (63.8%) or emergency (37.2%) stoma creation. Superficial surgical site and organ-related infection occurred in 6.8 and 4.2% of the patients, respectively [33]. In the two cohorts of the present study, it is not surprising that the rates of superficial wound infection (9 and 16%) and intra-abdominal abscess (7 and 6%) were higher, considering the fact that both cohorts exclusively underwent emergency surgery. In concordance with the present study, Sheetz et al. reported a complication rate of 55% and a 30-day mortality rate of 19% in those patients who underwent emergency bowel surgery [33]. Comparable results

were described in a study on emergency vs. elective procedures in general surgery [34]. Significantly higher morbidity (47.7 vs. 36.1%) and mortality (12.0 vs. 5.4%) rates were found in patients undergoing partial colectomy with colostomy under emergency conditions [34].

We noted two cases of early extraperitoneal/subcutaneous bowel perforation close to the mesh. In one case, the perforation was interpreted as iatrogenic due to insertion of a rectal tube. In the other case, the operating surgeon described the perforation at the mesh level, suggesting that the mesh might have caused the erosion. This is a feared complication following parastomal hernia repair [35], but no such case was reported in three randomised studies on prophylactic mesh placement [4]. Increased vulnerability of a distended and oedematous bowel under emergency conditions may potentially contribute to mesh erosion, and this issue has to be addressed in forthcoming studies.

The present study was limited by the lack of a randomised allocation of the study groups. In the mesh group, the rate of septicaemia was significantly higher than in the historic reference group. Focus on early warning signs of systemic inflammatory response syndrome was more prevalent after 2012 in our hospital. Moreover, it is noteworthy that the rate of faecal peritonitis was higher in the mesh group (before mesh insertion), although not statistically significant. There were no findings to suggest that the implanted mesh was the primary infectious site for the septic condition in any of the patients. A total of 26 patients were excluded from insertion of a prophylactic mesh without documented reasons. The 3-month mortality rate in this group was 42%, indicating that the surgeons in some cases chose not to insert a mesh in agreement with the guideline of the department. However, obliviousness may be the main reason for omitting use of mesh, as the exclusion rate decreased during the study period from 30% within the first 6 months to 10% within the last 6 months of the study period (data not shown) following increased awareness of the new procedure.

In conclusion, it was without increased complication rate to use a slowly resorbable synthetic light-weight mesh in a retromuscular position during emergency stoma formation, even in a severely contaminated field. In contrast with elective series, the present study failed to demonstrate a prophylactic effect on parastomal hernia development following emergency surgery. Further studies are warranted to modify mesh technique for hernia prevention to better compensate for the temporary inflammation and distension of ostomy bowel that is present during emergency conditions.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The study was approved by the Danish Data Protective Agency (J.nr. 2012-41-0566). Because the study design was descriptive and monitored current routine practice in the department, no approval of the study was required from the local ethical review board.

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