



Comparison of complete versus partial mesh removal for the treatment of chronic mesh infection after abdominal wall hernia repair

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Abstract

Purpose Treatment of chronic mesh infections (CMI) after parietal repair is difficult and not standardized. Our objective was to present the results of a standardized surgical treatment including maximal infected mesh removal.

Methods Patients who were referred to our center for chronic mesh infection were analyzed according to CMI risk factors, initial hernia prosthetic cure, CMI characteristics and treatments they received to achieve a cure.

Results Thirty-four patients (mean age 54 ± 13 years; range 23–72), were included. Initial prosthetic cure consisted of 26 incisional hernias and eight groin or umbilical hernias of which 21% were considered potentially contaminated because of three intestinal injuries, two stomas and two strangulated hernias. The mesh was synthetic in all cases. CMI appeared after a mean of 83 days (range 30–6740) and was characterized by chronic leaking in 52 cases (50%), an abscess in 22 cases (21%) and synchronous hernia recurrence in 17 cases (16.5%). Eighty-six reinterventions were necessary, including 36 mesh removals (42%), and 13 intestinal resections for entero-cutaneous fistula (15%). The CMI persistence rate was 81% (35 reinterventions out of 43) when mesh removal was voluntarily limited to infected and/or not incorporated material, but was 44% when mesh removal was voluntarily complete (19 reinterventions out of 43; $p < 0.001$). On average, 3.4 interventions (1–11) were necessary to achieve a cure, after 2.8 years (0–6). Fourteen incisional hernia recurrences occurred (41%).

Conclusions Treatment of chronic mesh infection is lengthy and resource-intensive, with a high risk of hernia recurrence. Maximal mesh removal is mandatory.

Keywords Mesh infection · Complete removal · Incisional hernia · Partial removal

Introduction

Parietal defect repair is one of the most common procedures performed by general surgeons. It has been well proven that prosthetic repair reduces the rate of recurrence [1] but mesh-related complications such as chronic mesh infection are

responsible for high morbidity and cost with a long-term risk of chronic surgical site infection of 2.1% [2]. Indeed, 4.5% of mesh removals are made necessary by infection [3] and patients often need multiple interventions [4].

There is no consensus regarding the treatment of such infections. Acute mesh infection can be treated with irrigation and antimicrobial therapy but chronic infections are much more difficult to cure, and there are numerous case reports and series in the literature with contradictory results [5–7]. Some suggest that complete mesh removal is required if we hope to achieve healing although the results of such a strategy are not consistent [8–13]. However, complete mesh removal was previously thought to be associated with high post-operative complication rates and high recurrence rates [13]. Others suggest that conservative treatment including wound management and antibiotics should be sufficient and would help reduce the risk of recurrence of hernia [14].

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Others have tried to determine the efficiency of partial removal of mesh involving removal of unintegrated mesh only, with encouraging results, but in small retrospective series [15].

Thus, the aim of this work was to present the results of a surgical treatment including maximal infected mesh removal in patients with chronic mesh infection after hernia repair, and to compare the outcomes of complete versus partial mesh removal.

Methods

Population and chronic mesh infection definition

Patients who were referred to our institution for chronic mesh infection (CMI) after parietal defect prosthetic repair between March 2007 and March 2016 were retrospectively included in this study. The database was registered (Ref: 2013770v0) with the French National Data Protection Agency (Commission Nationale Informatique et Libertés) and reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

We used the medical files to retrospectively gather epidemiological data (age, sex, and body mass index). Information regarding patients' medical history such as diabetes, smoking, immunosuppression, and chronic obstructive pulmonary disease (COPD) was also gathered. We then recorded the type of hernia (groin hernia, umbilical hernia, incisional hernia) and CMI risk factors during the first intervention (intestinal injury, stoma present, previous wound infection, infected mesh, septic dehiscence, strangulated hernia).

CMI was defined by the presence of local symptoms such as inflamed skin, chronic leaking, fistula, abscess, or prosthetic exposure, persisting despite conservative medical management including antibiotics and local care. The

occurrence of CMI was described according to its manifestations, time since mesh placement, cure and outcome.

The Breuing et al. classification (Ventral Hernia Working Group, VHVG grades) of CMI risk factors was used to separate the patients according to different risk grades at the time of mesh placement [16].

Interventions

Each time a patient passed through the operating room during the treatment of the CMI, for complete or partial mesh removal, was considered as an intervention. For each patient we noted the type of intervention, whether the removal was voluntarily complete or voluntarily partial, whether it led to complete or partial mesh removal, whether there was any interruption of the gastrointestinal tract, the number of interventions required to achieve healing, the delay between each intervention and the time from the first intervention until cure was achieved, and post-operative complications such as hernia recurrence rates.

Mesh removal was considered as apparently complete when no residual material, including mesh fragments and non-absorbable sutures, was visible at the end of the procedure. Mesh removal was considered as partial when the surgeon intentionally left prosthetic material considered as non-infected and fully integrated on visual appearance, in place. As previously described, the surgical technique for infected mesh removal included injection of indigo carmine blue into the fistula tract and excision of the tract, “blue-ectomy” removal of the infected material (stained blue), leaving the unstained embedded mesh in place and wall repair with placement of an intraperitoneal absorbable Vicryl mesh if necessary, and simple sutures of the consecutive aponeurotic defect or synchronous hernia recurrences (Fig. 1) [17]. Entero-prosthetic fistula was cured at the same time if necessary, with bowel resection and synchronous continuity restoration. No biologic mesh placement was employed.

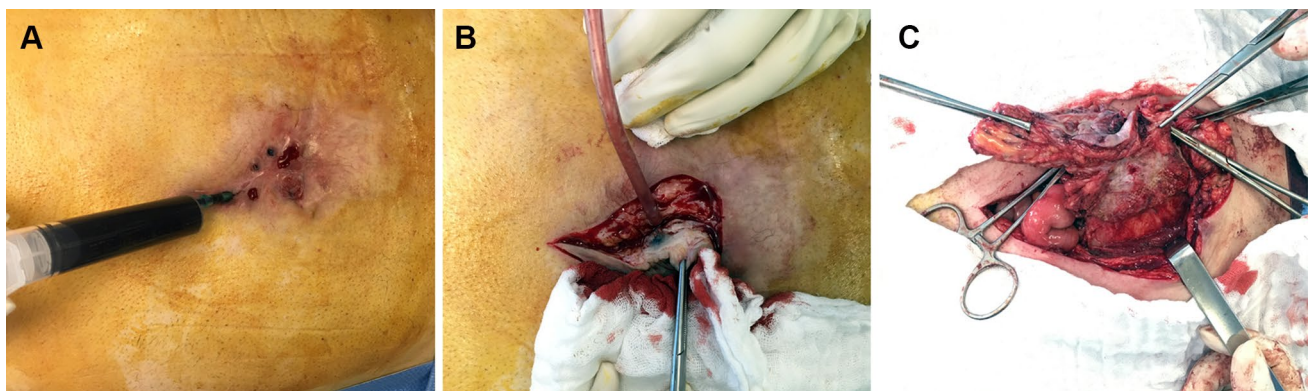


Fig. 1 Surgical strategy including identification of cutaneous fistula with indigo carmine blue (a), excision of the infected tract (b), and removal of infected material (mesh, non-absorbable suture, inflamed tissues) (c)

Cure was considered to have been achieved when no recurrence of CMI was reported when the patient was last seen at a post-operative appointment.

Hernia recurrence after mesh removal and definitive cure of CMI was diagnosed by physical and/or radiological examination.

Statistics

Categorical data are presented as percentages, whereas continuous variables are presented as means and standard deviations. McNemar's χ^2 test and Wilcoxon's signed rank test were used for paired data when appropriate. A value of $p \leq 0.05$ was considered significant. All analyses were performed using R, version 3.1.2. (The R Foundation for Statistical Computing, Vienna, Austria).

Results

Patients

In total, 34 patients were secondarily referred to our institution for CMI between March 2007 and March 2016. The epidemiological baseline features of the 34 patients at the time of hernia cure are summarized in Table 1.

Initial hernia and cure

Twenty-six patients had incisional hernia (76.5%) and eight had groin or umbilical hernia. Following repair seven patients (21%) were considered potentially contaminated (VHWG Grade 3), with three intestinal injuries with immediate suture, two stoma and two strangulated hernias that were operated on in an emergency. Patients were treated with prosthetic mesh in 100% of cases.

Chronic mesh infection (CMI)

CMI occurred after a median delay of 83 days (30–6740) after the parietal defect repair, and was characterized by chronic leaking in 52 cases (50%), an abscess in 22 cases (21%), inflamed skin in 13 cases (13%) and prosthetic exposure in three cases. Synchronous hernia recurrence was present in 17 cases (16.5%). In total, we noted 103 occurrences of sepsis which required surgical intervention among the 34 patients.

Interventions

In total, 103 interventions were conducted in our institution including 43 mesh removals considered as apparently complete (42%), 13 intestinal resections for

Table 1 Baseline characteristics of patients at the time of prior mesh placement

Variable	Patients, $n = 34$ (%)
Gender (female/male)	14/20
Age (years)	53.9 \pm 13 (23–72)
Body mass index (mean)	28.9 \pm 5.6 (22–40)
ASA	
1	5 (14.7)
2	16 (47)
3	13 (38.2)
4	0
Type of hernia	
Groin or umbilical hernia	8 (23.5)
Incisional hernia	26 (76.5)
Type of mesh	
Synthetic	34 (100)
Polypropylene	5 (14.7)
ePTFE	17 (50)
Polyester	4 (12)
Non specified type	8 (24)
Bioprosthetic or biologic	0
Mesh position	
Onlay	1 (3)
Sublay	10 (29)
Inlay	1 (3)
Underlay	11 (32)
Miscellaneous	11 (32)
Ventral Hernia Working Group score ^a	
Grade 1	5 (14.7)
Grade 2	22 (64.7)
Diabetes	11 (32)
Steroid treatment	1 (2.9)
Active smoker	10 (29)
Chronic obstructive pulmonary disease	4 (11.7)
Obesity	11 (32)
Grade 3	7 (20.6)
Strangulated hernia	2 (5.9)
Intestinal injury	3 (8.8)
Stoma present	2 (5.9)
Grade 4	0

VHWG Ventral Hernia Working Group, ASA American Society of Anesthesiologists, ePTFE expanded polytetrafluoroethylene

^aGrade 1: low risk patients with no history of infection. Grade 2: co-morbid patients (smoker, obese, diabetic, immunosuppressed, COPD). Grade 3: potentially contaminated patients (previous wound infection or stoma present during the prosthetic insertion or violation of the gastrointestinal tract during the operation). Grade 4: infected patients with infected mesh of septic dehiscence

entero-cutaneous fistula (13%), 4 stoma formations (4%), and 32 abscess evacuations (32%).

Mesh removal was considered as apparently complete (no residual visible material, including mesh fragments and non-absorbable sutures visible at the end of the procedure) in 43 cases but the CMI persisted in 19 patients resulting in a success rate of apparently complete mesh removal of 56%. Mesh removal was considered as partial (the surgeon intentionally left prosthetic material considered as non-infected and fully integrated in place) in 43 cases but the CMI persisted in 35 cases, leading to reoperation, thus resulting in a success rate of partial removal of 19% ($p < 0.001$) (Table 2; Fig. 2). As a result, complete mesh removal from the start was performed in seven patients (20.5%), complete mesh removal after the previous partial mesh removal(s) in 20 patients (59%), and one or more partial mesh removals (without complete mesh removal in the end) in seven patients (20.5%).

In total, the 34 patients underwent a mean number of 3.4 [1–11] operations to achieve cure of the CMI, after an average delay between the first operation for CMI and cure of 2.8 years (0–6).

Hernia recurrence

We recorded 14 cases (41%) of clinical hernia recurrence by the end of the treatment, after a mean follow-up period of 36 months. All of these had had a complete mesh removal, whereas the patient who had only undergone partial removal experienced no hernia recurrence by the end of follow-up ($p = 0.026$, Table 2). Five of them were reoperated, after an average of 17.5 months, with no CMI recurrence. The average follow-up period was 9.7 ± 10.6 months (0.3–46) for patients reoperated for hernia recurrence and with no sepsis recurrence. We used synthetic retromuscular mesh in four cases and, in a patient presenting with a persisting chronic sinus due a non-absorbable stitch, a biologic intraperitoneal mesh in one case.

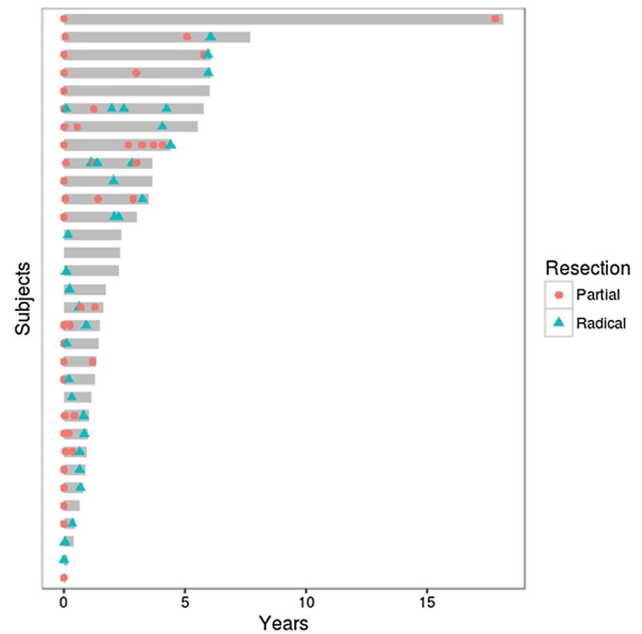


Fig. 2 Swimmer plot showing evolution of mesh infection according to surgical treatment type: voluntarily complete or voluntarily partial mesh removal, in the 34 subjects. Each grey line represents the medical history of a case. The red spots are the partial mesh removals and the blue triangles are the complete mesh removals. In most cases, the disease ends with a complete mesh removal, whereas, on the contrary, partial mesh removals are often followed by other interventions for CMI persistence. To ensure clarity in the figure, the two patients with the longest follow-up after partial mesh removal are not presented

Discussion

In this series, we found that chronic mesh infection after hernia repair is difficult to manage, with a high failure rate of mesh removal attempts, especially if partial, and long delays in abdominal wall healing.

Several factors are associated with prosthetic mesh infection, such as smoking, diabetes, immunosuppression, and obesity [16, 18]. It is also known that prosthetic mesh should not be used in very high risk situations such as in the presence of a stoma, strangulated hernia or intestinal injury. However, we recorded seven cases of patients in

Table 2 Comparison of outcomes between complete and partial mesh removal ($n = 86$) in the 34 patients

Surgery outcome in 34 patients	CMI not cured (%)	CMI cured (%)	Hernia recurrence (%)
Apparently complete mesh removal ($n = 43$)	19 (44)	24 (56)	14 (41)
Partial mesh removal ($n = 43$)	35 (81)	8 (19)	0
p value*	<0.001		0.026

CMI chronic mesh infection

*McNemar's χ^2 test

such situations who were treated with prosthetic mesh. The VHWG score is now considered as a useful tool for patient selection to prevent mesh infection [16, 19]. On the basis of these grades, the patient selection for partial mesh removal is also very important to achieve good results.

CMI also raises a diagnostic problem, because it can be expressed in multiple ways and is usually present after a delayed period following mesh repair [20, 21]. This was confirmed in our series with a median delay of 83 days between the prosthetic cure and the onset of infection; the most frequent manifestations of CMI were chronic leaking, abscess and inflamed skin.

The gold standard to achieve a cure in these situations has yet to be determined. Some authors recommend radical treatment involving complete removal of the mesh [7, 9, 13, 22]. However, this approach involves a high risk of hernia recurrence and morbidity [13, 23]. Our results were consistent with those of Bueno-Lledo et al. [13], because all patients that had a hernia recurrence had had a complete mesh removal. Therefore, other approaches have been tried. For example, Aguilar et al. successfully cured three cases of seromas with percutaneous drain, intravenous antibiotherapy and gentamicin (80 mg) with 20 mL of saline infused through the drain three times a day [7]. Trunzo et al. had similar success in two patients [5]. Other authors tried a conservative treatment involving antibiotics and vacuum therapy [14, 24, 25]. Sabbagh et al. also successfully tried a conservative approach on 25 patients [15] (Table 3). However, there is no clear definition of CMI healing and most of these studies had a relatively short-term follow-up (11–33 months). This can lead to the erroneous belief that cure has been achieved when the infection is in fact still present but at the infraclinical stage [5]. In addition, most of these studies were conducted on a small number of patients.

Another possible approach would be to use biologic meshes that have been developed for such complicated situations [26]. The non-human collagen matrix can support tissue regeneration through neovascularization and cell repopulation in a clinically acceptable timeframe and is resistant to infection [16, 27]. However, the level of evidence for their safety and efficacy remains low. The results of the SIMBI-OSE trial are currently being awaited with interest [28].

The type of material, mesh porosity and tissue reaction are currently considered the most critical factors for prosthesis incorporation into the abdominal wall. The main searched properties are to induce moderate local inflammation and to stimulate fibroblastic activity allowing the mesh rapid colonization and collagen fibers secretion ensuring the strength of the repair. Historically, three large family of mesh are the most used: polypropylene, polyester and polytetrafluoroethylene (ePTFE) based meshes. Pain, seroma and persisting infection were established as mesh-related complications and seems to be associated with small pore-sized,

Table 3 Literature review of the results of the management of chronic mesh infection, including the present series

Author (references)	Year	Number of cases	Onset of sepsis	PMR (%)	CMR (%)	Recurrence of CMI after PMR (%)	Recurrence of CMI after CMR (%)	Reoperation for sepsis recurrence	Abdominal wall closing procedure	Hernia recurrence rate after PMR (%)	Hernia recurrence after CMR (%)	Mean follow-up (months)
Sabbagh et al.	2012	25	NS	92	4	0	NA	1 (1–5)	Suture	20	58	40
Bueno-Lledo et al.	2016	48	NS	21	79	50	2.6	12.5	Suture (n=40) component separation mesh(n=6)	10	58	51.6
Akyol et al.	2013	15	Chronic	0	100	0	NA	0	Suture	NA	7	62
Chung et al.	2014	15	Chronic	55	45	70	37.5	33	Suture	30	37.5	19
Present series	2017	34	Chronic	50	50	81	44	3.4 (1–11)	Suture	0	41	36

CMR complete mesh removal, PMR partial mesh removal, CMI chronic mesh infection, na not applicable, ns not specified

heavy-weight meshes [29]. This type of mesh was used during the initial surgery in 15 of our patients. To improve the functional outcomes and decrease the rate of the mesh infection new types of synthetic prosthesis also called large pore-sized, light meshes were developed. Several studies showed the benefits of the large pore-sized, multifilament light-weight meshes over large pore-sized heavy-weight meshes in term of abdominal wall compliance, less chronic pain and chronic infection [30–32]. However, these data should be considered with caution. A meta-analysis did not find any difference in term of early complications; moreover, a trend for more recurrences was observed in the patients treated by light-weight meshes [33]. In this series, 17/26 patients with known type of mesh had a PTFE mesh (65%) and 60% of meshes were placed underlay or sublay. Finally, apart from type of mesh and mesh position, other confounding factors for the outcome are the initial contamination, type of hernia, the presence of an intestinal fistula and the duration of follow-up.

We compared how often cure was achieved after complete or partial mesh removal. Indeed some surgeons tend to avoid complete mesh removal because of the aponeurotic sacrifice it involves and the hernia recurrence risk that comes with it [34]. In our series, complete mesh removal was significantly more efficient than partial mesh removal, with only six patients cured out of the 45 cases with the latter intervention (Fig. 2). We also realized that even when surgeons intend to remove all the infected material, they often miss part of the mesh. In these chronically infected tissues it is often very hard to discriminate between different structures. Thus, we found numerous cases, where even though the surgeon thought he had removed all the infected tissue, the operation was later followed by others consisting of removal of the remaining infected mesh fragments.

CMI treatment can be prolonged (2.8 years in our series). The fact that several interventions are needed to achieve a cure (3.4 per patient in our series) is one of the reasons. To try and make treatment as short as possible and allow patients to go back to a normal life, radical measures should be taken as soon as possible. Therefore, we believe that partial mesh removal can be considered only if part of the prosthetic material seems well incorporated. As result, one or more partial mesh removals (without complete mesh removal in the end) could be performed in seven patients of this series (20.5%). In the case of complete failure there should be no other solution than complete mesh removal, because discrimination between healthy and infected mesh fragments is very difficult, whatever the aponeurotic sacrifice.

The main issue associated with this approach including maximal infected mesh removal is the high rate of hernia recurrence (47% in our series). In our ward we usually treat patients when the recurrence has an impact on their quality

of life. In our daily experience, no CMI recurrence was observed when the treatment of hernia recurrence was performed almost 1 year after the definitive cure of CMI. At the opposite, after groin hernia CMI, complete mesh removal ensures infection eradication and rarely results in hernia recurrence if sufficient fibrous scarring remains [35].

The retrospective nature and the small study size are important limitations of this work, concerning a rare condition. Another limitation of this study was the lack of the data concerning the type of mesh and their position employed during initial surgery. However, the results of this study may provide the foundation for the understanding, care, and management of these patients. Finally, we only included chronic mesh infection (no option for mesh salvage was considered, as in acute infection) and only cured patients, provided that the minimal follow-up could have been short in some cases.

In conclusion, CMI is a rare but difficult-to-cure complication of mesh repair of parietal defects. Conservative management can be an option but is very likely to lead to temporary and only apparent healing and might be associated with a very long treatment process. Complete mesh removal seems to be necessary in most cases to achieve a cure.

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Compliance with ethical standards

Conflict of interest SL, DM, AB, MMC, TP, KV, FP, and JLB declare no conflict of interest.

Ethical approval All procedures performed in studies involving human participants 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.

Research involving human and/or animal participants I hereby undersign and certificate that this article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent obtained from every patient prior to inclusion.

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