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ORIGINAL ARTICLE

Conservative management of mesh-site infection in hernia repair surgery: a case series

H. Meagher · M. Clarke Moloney · P. A. Grace

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Abstract
Purpose The aim of this study is to assess the outcome of conservative management of infected mesh grafts following abdominal wall hernia repair.
Methods This study retrospectively examined the charts of patients who developed mesh-site infection following surgery for abdominal hernia repair to determine how effective conservative management in the form of antibiotics and wound management was on the resolution of infection and wound healing.
Results Over a period of 30 months, 13 patients developed infected mesh grafts post-hernia repair surgery. Twelve patients were successfully treated conservatively with local wound care and antibiotics if clinically indicated. One patient returned to theatre to have the infected mesh removed. Of the patients that healed eleven were treated with negative pressure wound therapy (VAC®).
Conclusion This series of case studies indicate that conservative management of abdominal wall-infected hernia mesh cases is likely to be successful.

Keywords Infected mesh graft · Infected hernia · Conservative management · Negative pressure wound therapy · Abdominal hernia repair

H. Meagher
Department of Nursing, University Hospital Limerick, Limerick, Ireland

M. Clarke Moloney (✉) · P. A. Grace
Vascular Research Unit, University Hospital Limerick, Limerick, Ireland
e-mail: mary.clarkemoloney@hse.ie

Introduction

Abdominal wall hernias are common, and it is estimated that more than 20 million hernias are repaired worldwide every year [1]. Approximately 100,000 hernia repairs are carried out annually in the United Kingdom [2] and 700,000 in the USA [3]. Inguinal hernia is the most common type of hernia accounting for approximately 70 % of all hernias: in decreasing frequency are paraumbilical/umbilical (14 %), epigastric (6 %), incisional (4 %) and femoral (3.7 %) [4].

Mesh grafts to repair abdominal hernias may be either biologic (absorbable) or synthetic (non-absorbable) in origin. Biologic grafts are derived from either human or porcine dermis and are based on the concept of acting as a collagen and extracellular matrix scaffold where the host fibroblasts can create angiogenesis and lay down new collagen. Biologic mesh has been advocated for use mostly in contaminated fields [5–7]. However, its utilisation has remained limited in Europe as it is significantly more expensive than synthetic mesh options The use of prosthetic mesh has become accepted practice in the treatment for patients with abdominal wall hernias either by open surgery or laparoscopically. It has been shown that the use of mesh significantly reduces the rate of hernia recurrence by an average of 30 % compared to suture repair [8–11]. Polypropylene (PP) and polytetrafluoroethylene (PTFE) are the most commonly used mesh materials. The PP meshes are a monofilament polypropylene mesh, non-absorbable, inert, sterile and porous, approximately 0.44 mm thick. The e-PTFE mesh is 1-mm-thick mesh made from strong, soft inert and conformable e-PTFE with a structure that ensures early fixation to host tissue with minimal foreign body reaction [12]. Hernia repair with mesh is not without

complications; adhesions, chronic pain, migration, seromas, rejection of the mesh and mesh-related surgical site infections (SSIs) are all associated with the use of mesh in hernia repair [13–15]. A review paper from 2011 by Mavros et al. [16] cites the rate of mesh hernia infection at 5 %, although infection rates have been reported ranging from 0.001 to 13 % [14, 17–21]. Exact incidence reporting is challenging as infections can present from 2 to 39 months post-operatively [22]. Reported significant risk factors associated with mesh infections were smoking, American Society of Anesthesiologists (ASA) score of ≥3, age, duration of surgery and emergency operations, also it was noted that there was a greater risk of infections in obese patients (RR = 1.41) (14,15). Similarly, risk factors for SSI include age, co-morbidities/underlying illness, obesity, smoking, wound classification, and site and complexity of procedure [19]. However, these risk factors are also associated with risk of hernia recurrence when mesh is not used for a hernia repair [18]. Prophylactic antibiotics in hernia patients does not ensure protection against developing a post-operative abdominal infection [16]. Infected mesh wounds have traditionally been treated by surgically removing the mesh; this can be a challenging procedure with associated risks. Reports have recommended that infections involving non-absorbable mesh warrant early surgical removal [23, 24]; however, the findings from our case studies series would indicate that conservative treatment is a viable option for many of these patients.

Materials and methods

All patients during a 30-month period (September 2009 to end of June 2012) who developed a post-operative hernia repair deep wound infection, as defined using the CDC guidelines were included in this study [19]. Retrospective data on hernia procedures were gathered through the hospital inpatients enquiry system (HIPE). Details of deep infected hernia wounds with exposed mesh were recorded on the tissue viability department's database. Details of patients who developed a mesh-site infection were analysed using Statistical Package for Social Sciences (SPSS, version 18).

Variables analysed were demographic data, including age, BMI, co-morbidities, surgical procedure, length of surgery, level of surgeon, type of mesh used. Wound data included the number of days post-operatively infection occurred, wound measurements, swab culture, management of infection, wound management, length of hospital stay and time to wound healing. Time to healing was calculated from the time the wound reopened secondary to deep infection to full healing.

Results

Three hundred and forty-two patients underwent repair of abdominal wall hernia in the 30-month study period in this institution. The most common hernia repair was inguinal repair accounting for 43.9 % ($n = 150$) of all hernias operated on, the next most common were classified as incarcerated or strangulated hernias accounting for 22.2 % ($n = 76$) of hernias operated on in this institution. Further details of hernia procedures are given in Table 1. Thirteen patients (3.8 %), five men and eight women, developed a deep wound infection following hernia repair, of these eleven were operated on by consultant surgeons and two by registrars. Twelve patients were treated conservatively with local wound care and antibiotics when clinically indicated, one returned to theatre to have the mesh removed. Of the cases which were successfully treated conservatively, seven were incisional hernias, two paraumbilical hernias, two strangulated/incarcerated inguinal hernias and one inguinal hernia. All patients were operated on under general anaesthetic. Three procedures were emergency cases, seven were elective surgery and two were redo procedures. Ten patients had intravenous prophylactic antibiotics administered. Average length of surgery was 125 min (range 70–190 min). Median age was 60.5 (range 47–80). One quarter of the sample were smokers ($n = 3$). Only two patients had a normal body mass index (BMI), the remaining patients were obese (BMI > 30), super obese (BMI > 35) or morbidly obese (BMI > 40). Four patients had an ASA score of 3, seven had a score of 2 and one scored 1. Characteristics of these patients are detailed in Table 2. Four different types of mesh were used in the repair of these hernias, Primilene® (monofilament polypropylene), Permacol™ (biologic Implant), Prolene™ (polypropylene) and Vypro® (multifilament polypropylene) mesh. Table 3 details the frequency which each mesh was used in these cases.

Wound infection was diagnosed using the CDC guidelines on deep incisional surgical site infections [19]. Figure 1 shows a typical presentation of a deep surgical

Table 1 Details of hernia repair procedures over a 30-month period

Type of hernia	Numbers	Overall percentage (%)
Inguinal	150	43.9
Incarcerated/strangulated	76	22.2
Paraumbilical/umbilical	41	12
Incisional	48	14
Femoral	19	5.6
Epigastric	6	2
Diaphragmatic	1	0.3
Total	342	100

Table 2 Characteristics of conservatively treated infected mesh patients

Subject number	ASA score	Diabetes	Smoker	BMI	Surgical procedure	Type procedure	Readmitted due to infection
1	2	NIDDM	Yes	Super obese	Incisional	Redo	Yes
2	2	NIDDM	No	Morbidly obese	Incisional	Routine	Yes
3	3	NIDDM	No	Morbidly obese	Strangulated paraumbilical	Emergency	Yes
4	3	NIDDM	Yes	Normal	Incisional	Routine	Yes
5	2	NIDDM	No	Morbidly obese	Incarcerated hernia	Emergency	Yes
6	2	NO	No	Obese	Incisional	Routine	Yes
7	3	NIDDM	No	Super obese	Paraumbilical hernia	Emergency	Yes
8	2	NIDDM	No	Obese	Inguinal	Routine	No
9	1	No	Yes	Normal	Incisional	Routine	Yes
10	3	NIDDM	No	Morbidly obese	Paraumbilical	Routine	Yes
11		No	No	Morbidly obese	Incisional	Routine	Yes
12	2	NIDDM	No	Super obese	Incisional	Redo	Yes

Table 3 Frequency of mesh used in hernia repairs ($n = 12$)

	Frequency	Percent
Type mesh		
Primilene®	3	25.0
Permacol™	1	8.3
Primilene® and Permacol™	2	16.7
Prolene™	1	8.3
Vypro®	5	41.7
Total	12	100.0

site infection in a patient with a mesh in situ following hernia repair. Eleven of the patients treated conservatively in this case series had deep wound infection with dehiscence of the superficial wound layers down to the mesh, one had a narrow deep sinus wound. These wounds were of varying sizes with median measurements as follows; length 3.6 cm (range 2–46 cm), width 4.9 cm (2–46 cm) and depth 4.5 cm (range 2–14 cm). A variety of bacteria were isolated from the infected wound swabs including *Staphylococcus aureus* ($n = 4$), Methicillin-resistant *Staphylococcus aureus* ($n = 4$), vancomycin-resistant *Enterococcus* ($n = 3$), *Pseudomonas* ($n = 1$) and *coagulase negative staphylococci* ($n = 1$). Eleven of the patients ($n = 11$) required readmission to hospital for IV antibiotics and local wound care management. The twelfth patient, who had a deep sinus wound, was treated as an outpatient attending daily dressing clinics and did not require systemic antibiotics, nor was treated with negative pressure wound therapy (NPWT) as the wound sinus was too narrow to use a foam wick.

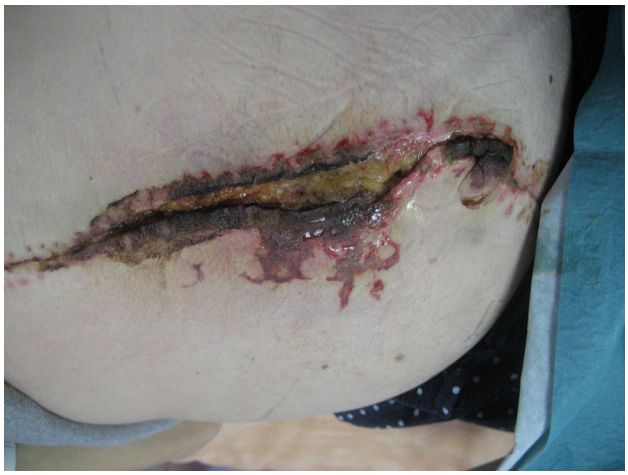

Fig. 1 Typical first presentation of infected mesh wound

The remaining 11 patients were all treated with NPWT, VAC® (vacuum-assisted closure). Figure 2a–c demonstrates the progress from exposed mesh caused by deep wound infection, to full wound healing following treatment with NPWT. One of these patients was not compliant with VAC® following 10 days of treatment and therefore was changed to conventional dressings. Treatment with VAC® in the remaining 10 patients continued until the wound was superficial when conventional dressings replaced the VAC® until the wound was fully closed. Patients treated with VAC® required dressings 3 times weekly. Time to

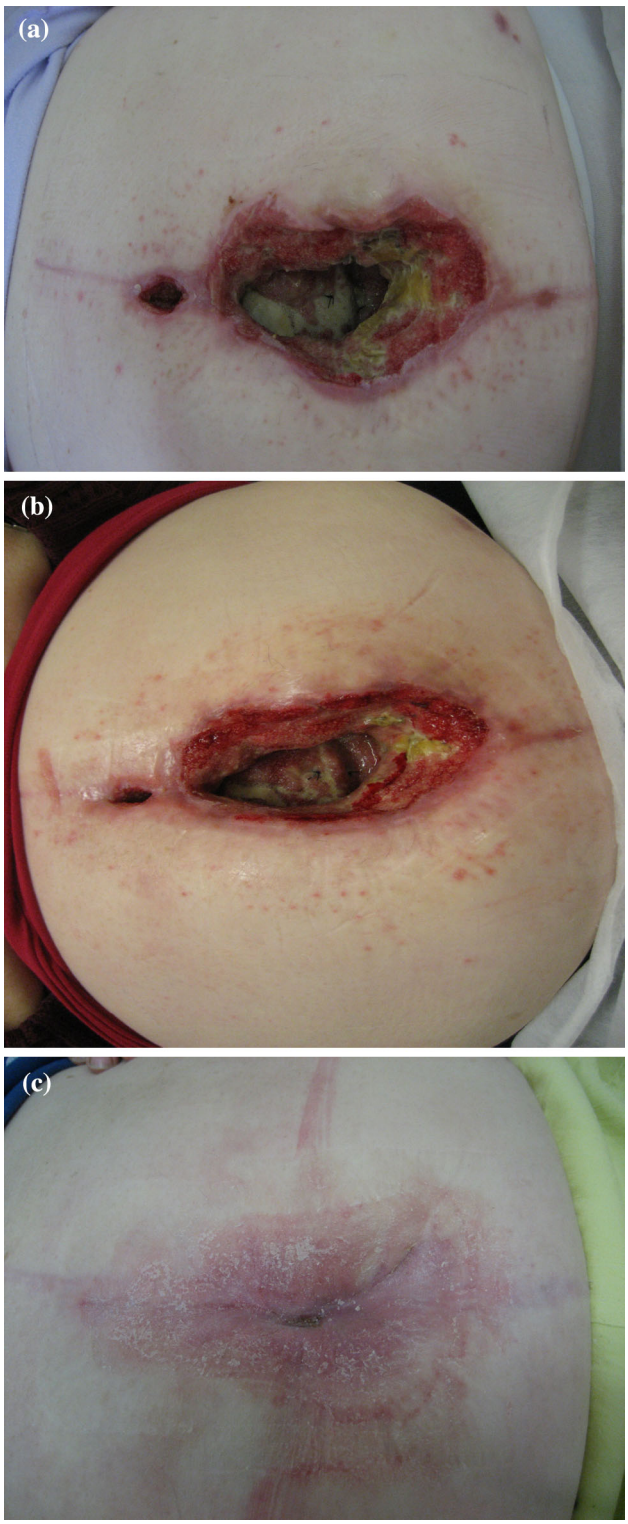

Fig. 2 **a** Visible mesh following wound dehiscence and local debridement of devitalised tissue as a result of deep surgical site infection following hernia repair. **b** Same wound showing good evidence of granulation tissue covering the exposed mesh following commencing NPWT. **c** Wound fully healed following 7 months of NPWT

healing in these patients varied considerably, median time to heal was 199 days (range 82–456 days). The median number of hospital bed days occupied by these patients was 27 days (range 7–60 days). All were followed up for a prolonged period of time on an outpatient basis until complete healing was achieved.

Costs associated with NPWT for these patients included rental of the VAC® machine and the cost of associated consumables, such as the foam and dressings. VAC® was rented for a median of 103 days (range 10–192 days) per patient, at a median cost of €4,650 (range €354–€8,668) plus additional cost of consumables at a median cost of €1,939 (range €200–€5,975).

The patient who required surgical removal of the mesh failed to progress to healing despite prolonged (2 years) treatment with NPWT and antibiotics when clinically indicated. This patient developed recurrent deep wound infection until the mesh was removed and subsequent to this developed hernia recurrence.

Discussion

SSI generally refers to infection in a wound which occurs following a surgical procedure. SSIs are one of the most common health care-associated infections [19]. According to a prevalence survey carried out by the Hospital Infection Society in 2006, Ireland has a SSI rate of 4.6 % [25]. This is similar to the rate in England (4.65 %), higher than the rate in Northern Ireland (3.69 %) and lower than the rate in Wales (5.65 %) [25]. However, it is thought that prevalence studies may underestimate rates as many SSIs occur following discharge from hospital [19]. Although SSIs often only affect the superficial tissues, more serious deeper infections may occur [19]. The Center for Disease Control defines 3 levels of SSI, superficial incisional (affecting skin and subcutaneous tissue), deep incisional (affecting fascial and muscle layers) and organ/space infection (involving anatomy other than the incision which is manipulated during surgery) [26]. Superficial and deep surgical site infections are most commonly related to mesh infection. Infected mesh as a post-operative complication of hernia surgery affecting up to 13.6 % of patients [14], with wound-related complications affecting 33 % of patients post-operatively [15]. Although SSIs usually manifest within 30 days of surgery, most frequently between days 5 and 10 post-operatively [13], mesh infections have been reported from 2 to 39 months post-operatively [22]. This means accurate incidence reporting is challenging.

Because of the normal colonisation of skin with microorganisms which can cause infection, SSI diagnosis

is based on clinical signs and symptoms of infection rather than microbiological culture alone [19]. Similar to previous reports, [27–30], microbiological cultures in this case series demonstrated *Staphylococcus aureus* ($n = 4$) and methicillin-resistant *Staphylococcus aureus* ($n = 4$), closely followed by vancomycin-resistant *Enterococcus* ($n = 3$), to be the most common organisms cultured from infected mesh wounds.

SSIs are thought to double the length of hospital stay for patients [19], with an average increase in bed days of 6.5 days per patient and therefore are costly in terms of both morbidity and economically [19, 25]. The extra costs include surgical, medical and nursing interventions and additional pharmaceuticals. Our incidence of wound infection in patients who have undergone mesh hernia repair (3.8 %) in this institution is similar to that reported by Luijendijk et al. [12] who reported an incidence of 3.7 %.

Biologic mesh has been identified as being of value in certain abdominal wall hernia repairs due to their ability to resist infection, but because of the high cost of these meshes, surgeons need to be selective in their use [31]. In 2010, a framework was developed to grade hernias to identify patients who may benefit from the use of a biologic mesh graft in reducing the risk of infection [32]. Grade 1 patients are those with no history of wound infection. Grade 2 patients include those with co-morbidities for example, diabetes, immunosuppressed conditions, chronic obstructive pulmonary disease, obesity and tobacco use. Grade 3 patients are those with a potentially contaminated field; they may have had a previous wound infection, or have an enterostomy or known entry to the gastrointestinal tract during surgery. Grade 4 patients are those with ongoing infections, specifically infected mesh and wound dehiscence [32]. Grade 3 and Grade 4 hernias were identified as being suitable candidates for a biologic mesh graft [32]. The use of biologic grafts is supported in the literature mainly with case series reports and although demonstrating greater resistance to infection than its synthetic counterparts, infection in patients with biologic mesh grafts is not unknown [33, 34]. In our own case series, we reported one case of a patient developing a deep infection post-implantation of a biologic mesh (Permacol™). Further quality prospective research trials are needed to fully evaluate the monetary and clinical value of using biologic grafts before increased use can be justified.

Prosthetic mesh is most commonly used as part of abdominal wall hernia repairs due to its success in reducing hernia recurrence [9]. However, it is associated with a greater risk of infection which traditionally would have necessitated a return trip to the operating theatre for the patient, removal of the infected mesh and probable recurrence of the hernia [23]. Due to the potential difficulty in mesh removal and the associated potential for hernia recurrence [12, 21], an increasing number of case studies have been published which have detailed successful mesh salvage by treating these cases conservatively with a variety of different treatments [16, 24]. Stremitzer et al. [23] advocated the conservative management for the cases of infection in the presence of absorbable mesh grafts and recommended the surgical removal of infected non-absorbable meshes [23]. However, our own case series would dispute this having successfully treated both absorbable and non-absorbable infected mesh cases conservatively. The success of the case studies detailed in this paper may be due to the use of VAC® NPWT. Negative pressure promotes wound healing by applying subatmospheric pressure to a wound bed [35, 36]. It is reported that NPWT increases the rate of angiogenesis, endothelial proliferation, capillary basement membrane integrity, capillary blood flow, capillary calibre, and reduces oedema and bacteria levels in the wound bed, thereby facilitating healing [37, 38]. A number of published studies have already proven the effectiveness of NPWT in assisting abdominal wall closure and in particular in cases of abdominal sepsis [39, 40], and more recently, Berrevoet et al. [41] report the effectiveness of negative pressure as an effective option for infected mesh wounds [41].

Despite the significant size and depth of the wounds and the extensive amount of exudate produced, our patients were successfully managed in a community setting using NPWT, therefore avoiding unnecessary hospital inpatient stay and a return to the operating theatre. We acknowledge that the costs associated with NPWT are significant; however, if compared to the potential costs associated with additional hospital bed days and an operation to remove the mesh, we would argue that the seemingly more cost-effective solution is conservative management. However, as this case study series did not seek to provide a cost-effectiveness analysis on these two options, this subject may be a topic for future research.

Patient-related factors, including diabetes, morbid obesity, nutritional deficit, smoking, steroid therapy and renal disease, have been associated with increased risk of developing a mesh-related infection [14, 15, 22, 27, 30]. This is as a result of reduced perfusion of the skin and subcutaneous tissue and immunosuppression linked to these co-morbidities [42]. This link is evident from our relatively small sample size, with over two-thirds of the sample ($n = 9$) having diabetes, one quarter were smokers ($n = 3$) and the majority ranged from obese to super morbid obesity ($n = 9$).

Conclusion

This series of case studies indicates that patients with infected abdominal wall hernia mesh may be successfully

treated using conservative methods and this treatment should be the first line of treatment for such patients.

Conflict of interest None.

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