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ORIGINAL ARTICLE

Study of mesh infection management following inguinal hernioplasty with an analysis of risk factors: a 10-year experience

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Abstract

Purpose We present a review of our 10-year experience in managing patients with mesh infection following hernioplasty and analyze the occurrence of known predisposing factors.

Methods We analyzed 392 cases of mesh infection treated at our center between 2007 and 2018 after a preoperative work-up. (Thirty-one patients underwent the primary hernia repair procedure at our hospital, whereas the others underwent the primary surgery at other local centers and were referred to our center.) The method of infected mesh removal (open or laparoscopic) was selected depending on the primary surgical approach. Open repair involved the excision of the mesh, infected tissue, and sinus (if present). The laparoscopic approach was used to identify the abscess, excise the mesh, and allow drainage into the preperitoneal space.

Results The operative course in all patients was uneventful. A second surgery to extract the residual mesh around the pubic bone was performed in 7 patients. Hernia recurred in 29 patients after mesh removal. The discharge culture results were positive in 193 patients. Of these, *Staphylococcus* spp. was identified as the causative organism in 126 patients. Risk factors for mesh infection, including obesity, smoking, and diabetes, were identified in 182 (46.5%), 154 (39.3%), and 35 (8.9%) patients, respectively.

Conclusions It is recommended the approach of mesh removal is tailored as per the primary hernioplasty method. We analyzed the occurrence of risk factors for mesh infection in this study, but further studies are needed to develop a predictive model that is both internally and externally validated to evaluate the probability of mesh infection.

Keywords Mesh infection · Risk factors · Inguinal hernia repair · Hernioplasty

Introduction

The use of a synthetic mesh for hernioplasty has significantly reduced hernia recurrence rates [1]. Although the incidence of mesh infection is low, its management can be complicated. Latest studies have reported postoperative infection rates varying from as low as 0.7–2% after laparoscopic ventral hernia repair to as high as 6–10% following open inguinal hernia repair [2, 3]. Different methods for treatment of mesh infection have been reported, but no available study gives a thorough summary of the various therapeutic modalities.

The aim of the present study was to review cases of mesh infection managed at our center over the last 10 years to analyze the clinical and demographic data of the operated patients and to summarize our management principles because our center is the largest training center for hernia surgery in China; therefore, numerous complicated cases are referred to us.

Materials and methods

We reviewed the data of 392 patients with mesh infection treated at our center over last 10 years (Jan 2007 to June 2018). Inclusion criteria were mesh infection after inguinal hernioplasty without response to conservative treatment, or previously incomplete mesh excision prior to referral to our

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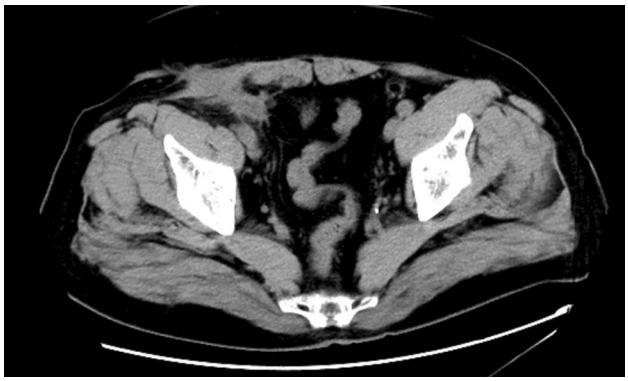

Fig. 1 CT scan of a patient 2 years after right inguinal hernia repair with intermittent wound discharge

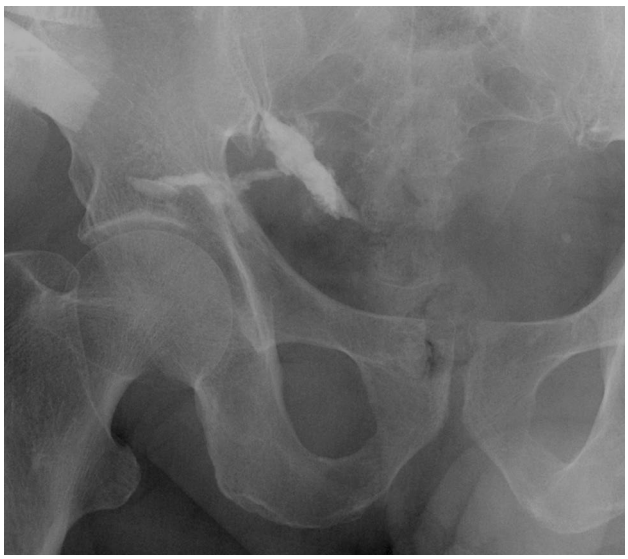

Fig. 2 Sinogram of the same patient

hospital. Before the management, inform consent has been obtained from all the patients. The operative findings and follow-up data of all patients were collated and examined.

The preoperative work-up included computed tomography (CT) scans of all patients (Figs. 1, 2). We also performed a sinus contrast radiography in patients with an abdominal wall sinus to explore the tract and determine whether the sinus was connected to any of the internal organs such as the bladder, colon, or the small intestine. The pus, or any other discharge from the unhealed wound or abdominal wall sinus, was collected for culture and sensitivity testing to guide intravenous antibiotic usage.

The decision to remove the mesh was made for patients who showed a poor response to conservative treatment or those who demonstrated extensive fluid collection around the mesh on CT imaging (more than 1 cm thickness around mesh and persistent symptoms after antibiotic treatment). The approach to management is described in Fig. 3. The method of mesh removal (open or laparoscopic) was selected depending on the primary surgical approach. If the patient had undergone an open hernioplasty, an open approach was utilized for excising the infected sinus, mesh, and the affected tissue. In post-laparoscopic hernioplasty patients, the laparoscopic method was employed to identify the abscess, excise the mesh, and allow drainage in the preperitoneal space. The details of the latter technique have been documented in our previous paper [4].

Intravenous antibiotics were administered according to the findings of the pus culture and sensitivity report. The quantity of drainage was monitored, and the drain was eventually removed after the evacuation of excess fluid was confirmed on an ultrasonography or a CT scan.

The software SPSS 16.0 was used for statistical analysis.

Results

The data of total 392 cases (361 males and 31 females) were reviewed in this study. The average age of the study group was 61.6 years, and the average body mass index (BMI) was 24.9 kg/m^2. Of these, 31 patients had undergone the primary hernia repair procedure at our hospital (two were emergency), whereas the others underwent the primary surgery at other local centers (21 were emergency).

The primary procedure performed in 369 patients was an open inguinal hernioplasty using techniques such as plug repair, preperitoneal mesh repair, and Lichtenstein repair. In the remaining 23 patients, a laparoscopic approach was employed for performing the primary hernia repair procedures, which included trans-abdominal preperitoneal (TAPP) repair and extraperitoneal (TEP) repair.

The time duration from the first hernia surgery to the diagnosis of infection was <3 months in 61 patients, between 3 months and 1 year in 258 patients, and >1 year in 73 patients. The median time was 9.6 ± 7.2 months. The affected patients presented with symptoms including local swelling, erythema, and pain, with or without discharge. The laboratory test results revealed hyperleukocytosis and elevated C-reactive protein levels in most patients. The abdominal CT examination findings showed extensive infection surrounding the implanted mesh.

In 2 patients, the abscess had led to the development of a small fistula that opened into the sigmoid colon. In these patients, a simultaneous repair procedure was performed after preoperative bowel preparation. The fistula was found to connect to the small intestine in 6 patients for whom a simultaneous bowel resection and anastomosis was performed. The operations were uneventful in all patients, with no sequelae of serious complications or mortality. The operative duration ranged from 70 to 130 min, and the extent

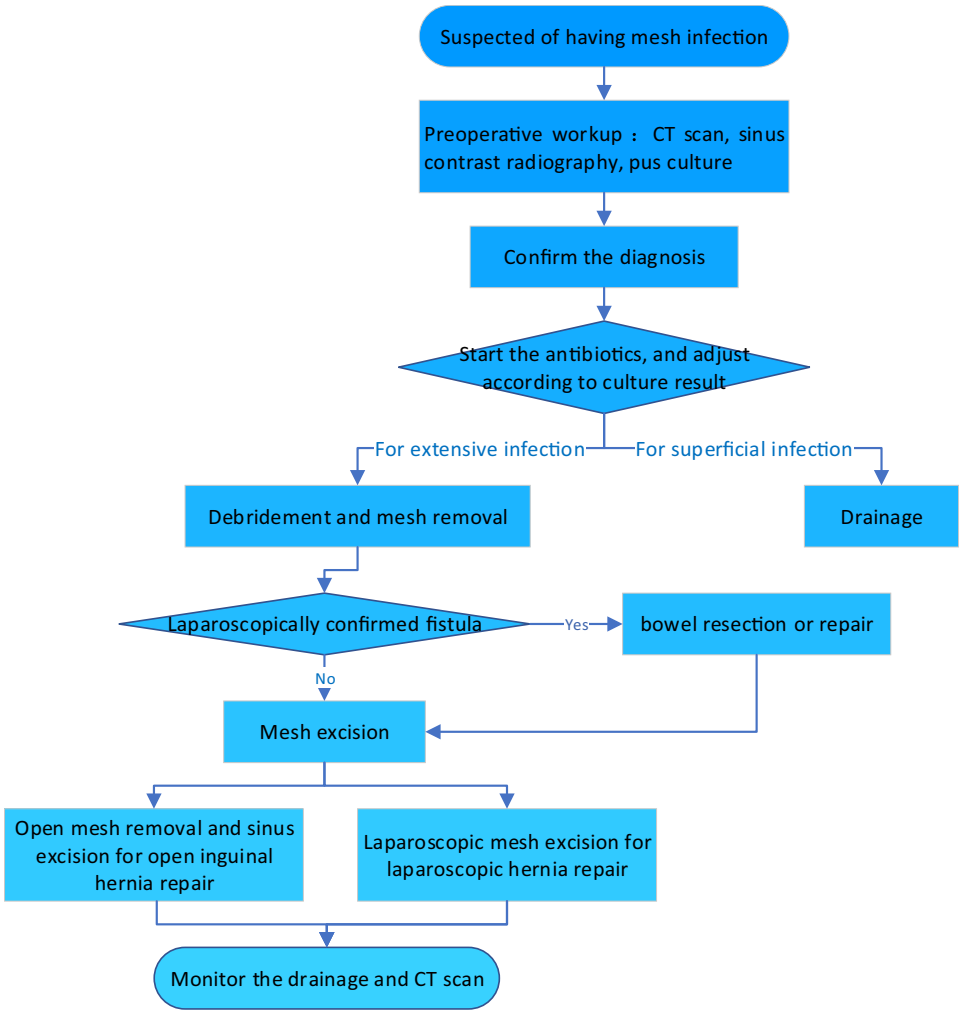

Fig. 3 Approach to management of mesh infection

of blood loss observed was 20–110 mL. A patient who had undergone a previous bilateral TAPP surgery underwent a second procedure for laparoscopic removal of the infected mesh on the contralateral side (6 months after the first excision). A second procedure for extracting the residual mesh around the pubic bone was performed in 7 patients (1 laparoscopic and 6 open).

The follow-up duration ranged from 6 to 47 months. The hernia recurred in 29 patients (7.4%) and developed within 24-34 months following mesh removal. The results of the bacteriological analyses were positive in 193 patients. The bacteria identified on culture of the discharge samples included *Staphylococcus* spp. ($n=126$), *Escherichia coli* ($n=18$), *Pseudomonas* spp. ($n=15$), and *Staphylococcus epidermidis* ($n=13$) (Table 1). Of these, 13 patients had MRSA infection.

The known risk factors for mesh infection, including obesity (BMI > 25), smoking, and diabetes, were identified in 182 (46.5%), 154 (39.3%), and 35 (8.9%) patients, respectively. The preoperative history and examination findings of the 31 patients who underwent the primary surgery in our center revealed that 13 (31.7%) were obese (BMI > 25), 11 (35.5%) were smokers, and 5 (16.3%) were diabetic. The infection rate was 0.14% in our center (a total of 20,964 inguinal hernia operations during this period). We had

Table 1 Culture results in 193 cases

Organism	Number
Gram positive	151
Staphylococcus spp.	126
Staphylococcus epidermidis	13
Others	12
Gram negative	42
Escherichia coli	18
Pseudomonas spp.	15
Klebsiella pneumoniae	6
Others	3
Total	193

performed an initial preperitoneal repair, plug repair, and Lichtenstein repair in 12, 2, and 17 patients, respectively, and 2 patients had emergency procedure. The average operative duration was 59.6 min (range 35–140 min). A postoperative scrotal hematoma was found to develop in 6 (19.4%) patients.

Discussion

In this retrospective study, we reviewed our experience in the management of mesh infection after inguinal hernioplasty over the last 10 years and estimated the occurrence of the associated risk factors among the included patients. The previous data showed that the laparoscopic inguinal hernia repair is associated with a lower incidence of mesh infection than an open procedure [5]. This might be a result of the mesh being directly introduced through the port into the preperitoneal space during laparoscopic repair, due to which it has minimal contact with the surrounding skin and tissue. In addition, the mesh is placed in the preperitoneal space, which is not close to the incision, in contrast to the open procedure. However, thorough sterilization of laparoscopic instruments is more challenging, and the instruments are more prone to carry debris or organisms that can lead to infections [6].

A few studies that have investigated the risk factors for mesh infection have found that patients with a history of infection, chronic obstructive pulmonary disease, obesity, smoking, diabetes, and immunodeficiency are more likely to develop postoperative infection [2]. Other perioperative predisposing factors include a long operative duration, postoperative hematoma formation, development of recurrent seroma requiring repeated aspiration, use of improperly sterilized instruments, and performance of concomitant procedures that can lead to contamination [7–9]. Some studies have clearly reported that patients with a BMI > 25 kg/m^2 had 50% higher risk of surgical site infection than those with a normal body weight, thereby concluding that obesity is an independent risk factor for mesh infection following inguinal hernia repair [10, 11]. In our study, ~ 50% of the 392 patients with mesh infection had a BMI > 25 kg/m^2. Of the 31 patients who underwent the primary surgery at our center, > 30% were obese. These figures are corroborative of those reported in previous papers and raise an important question of whether prophylactic antibiotics should be considered in all obese patients undergoing inguinal hernia repair. We were unable to determine the frequency of infection in this study because most of the patients were referred to us from other centers.

The commonly identified causative organisms in cases of mesh infection include the Gram-positive *Staphylococcus* (primarily *S. aureus*) and *Streptococcus* spp., the Gram-negative bacteria belonging to the *Enterobacteriaceae* family, and anaerobic bacteria including *Peptostreptococcus* spp. [12]. Attachment of the bacteria to the mesh is considered the first step, with subsequent bacterial proliferation and biofilm formation on the surface of the mesh, leading to mesh infection [13]. The biofilm shields the bacteria from antibiotics, which makes the infection persistent and resistant to antibiotics [14, 15]. This raises the question of whether prophylactic antibiotics should be administered in patients, in anticipation of the biofilm formation.

The diagnosis of mesh infection is straightforward; however, the optimal treatment remains unclear. Although the general principles of debris clearance and antibiotic administration are applicable, there are no evidence-based guidelines about the optimal duration of the effective treatment for persistent infection. There is no consensus on how long should the conservative management be continued in patients who show a sub-optimal or no response to treatment before deciding to proceed with surgical mesh removal [16]. In our study, some referral patients had been managed conservatively with antibiotics or percutaneous drainage at other local centers, without success. Several patients had also undergone an incomplete mesh removal and developed a subsequent recurrent infection. Therefore, complete mesh excision is the final solution for cases with extensive mesh infection. A previous study has reported the importance of removing the mesh completely to cure the infection [12]. In addition, in a study by Fawole et al. [17], only 2 out of 14 patients were found to suffer a recurrence at a mean follow-up period of 44 months, which showed that excision of the mesh does not substantially increase the risk of recurrence or residual pain. Of the patients primarily operated at our center, 29 cases of recurrence were identified during the follow-up, the earliest at 24 months after mesh removal. This number may increase with a longer follow-up duration.

The traditional method of mesh excision is via an open approach. It involves a complete removal of the mesh, the infected sinus, and the surrounding infected tissue, followed by proper drainage of the surgical site. In a recent study, we reported our experience in managing mesh infection after laparoscopic inguinal hernia repair [4], based on the findings of which we concluded that laparoscopic mesh excision is an effective and minimally invasive method as it prevents an unnecessary disruption of the healthy layers of the abdominal wall. Therefore, the operative approach to mesh removal is recommended to be tailored according to the primary surgical method.

Despite analyzing the known risk factors for mesh infection in our study, no definite conclusion has been drawn for preventing their occurrence. Further exhaustive studies are needed to develop a predictive model that is both internally and externally validated to evaluate the probability of mesh infection. In addition, a comparative study is necessary to

further clarify which patients could be managed conservatively alone versus those who require surgical intervention.

Authors' contributions HY wrote the manuscript. YX collected the data for this study. YS and JC supervised the study.

Compliance with ethical standards

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

Ethical approval This study complied the current law of China.

Human and animal rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Inform consent was obtained from all individual participants included in this study.

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