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ORIGINAL ARTICLE

Treatment of mesh infection after inguinal hernia repair: 3-year experience with 120 patients

Zhenyu Zou[1] · Jinxin Cao[1] · Yilin Zhu[1] · Qiuyue Ma[1] · Jie Chen[1]

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Abstract

Purpose Mesh infection is a devastating complication of sterile hernia repair surgery. This study was performed to assess the short- and long-term outcomes following treatment for mesh infection after inguinal hernia repair.

Methods This single-center retrospective study included all patients who developed mesh infection after inguinal hernia repair from January 2018 to December 2020. Patient demographics, mesh infection characteristics, microbiology, features of surgery, short- and long-term outcomes, and follow-up data were analyzed.

Results In total, 120 patients (8 women, 112 men; mean age, 54.4 years; mean body mass index, 24.8 kg/m^2) were treated for mesh infection. The cultures were positive in 88 patients; 62.5% of these were positive for *Staphylococcus aureus*. Laparoscopic exploration was performed in 108 patients. Seventy patients underwent complete removal of infected mesh, and 50 underwent partial removal. During the short-term follow-up, 11 patients developed a minor wound infection and were treated with dressings and antibiotics, 1 developed a wound infection requiring debridement, 30 developed seromas, and 3 developed hematomas that did not require surgical intervention. During the mean follow-up of 39.1 months, 4 patients developed hernia recurrence, 2 experienced chronic pain, and 23 developed recurrent infection requiring reoperation in the partial mesh removal group (in contrast, only 4 patients in the complete mesh removal group developed recurrent infection, with a statistically significant difference).

Conclusion The outcome of mesh infection after inguinal hernia repair treated by mesh removal is satisfactory. Systematic individualized treatment by experienced experts based on the patient's previous repair technique, implanted mesh, and physical condition is recommended.

Keywords Inguinal hernia repair · Mesh infection · Mesh removal · Treatment

Introduction

More than 20 million patients undergo groin hernia repair every year worldwide [1]. Utilization of prosthetic material was introduced in the 1960s. Favorable long-term results of these mesh repairs allowed their adoption in larger groups of patients [2]. Synthetic permanent meshes have been the gold standard to prevent recurrence for several decades [3]. However, as recurrence rates have decreased, the focus has shifted toward other postoperative complications such as infection, chronic pain, foreign body sensation, and erosion of adjacent organs.

In most cases, inguinal hernia surgery is performed to improve the patient's quality of life rather than to save his or her life. Patients have high expectations for the outcome of the surgery. Thus, mesh infection is a devastating complication of sterile hernia repair surgery. One study showed that the incidence of mesh infection after abdominal hernia repair ranged from 1 to 4% [4]. Once mesh infection occurs, surgical removal of mesh is almost always needed. However, conservative management can be a substitute in certain circumstances [5, 6]. Because most data on postoperative mesh infection have been obtained from studies with small sample sizes, single institutions, or a single author's experience, there is no high-level evidence or guideline-based recommendations. Surgeons must carry out targeted treatment

✉ Jie Chen
chenjiejoe@sina.com

[1] Department of Hernia and Abdominal Wall Surgery, Beijing Chaoyang Hospital, Capital Medical University, 5 Jingyuan Road, Shijingshan District, Beijing 100043, China

according to each patient's health condition, bacteriological characteristics, previous surgeries, and implanted meshes.

Whether an infected mesh must be totally removed, the right timing for mesh removal, the role of laparoscopy, and guidelines on how to treat the abdominal wall must be discussed. In this study, we retrospectively analyzed a case series of mesh infection after inguinal hernia repair and evaluated the short- and long-term outcomes of patients who underwent infected mesh removal.

Patients and methods

This retrospective analysis involved all patients with mesh infection who underwent mesh removal at Beijing Chaoyang Hospital (Beijing, China) from January 2018 to December 2020. All patients underwent their primary hernia repair at other local centers, and some had undergone unsuccessful conservative management before referral to our center. Patients who underwent mesh removal surgery at local centers were excluded. All patients provided written informed consent prior to the present study, which was approved by the Ethics Committee of Beijing Chaoyang Hospital.

The preoperative preparation included computed tomography (CT) in all patients and contrast fistulography in patients with an abdominal wall sinus to explore the morphology of the infection and determine whether internal organs such as the bladder, colon, or small intestine were involved. Pus or exudate from the sinus was collected for bacterial culture and drug allergy testing. A gastric tube and urinary catheter were advanced in all patients before surgery. Empirical antibiotics were utilized initially and adjusted based on the results of the bacterial susceptibility testing.

Surgery was performed under general anesthesia in all patients. The first step was to thoroughly explore the abdominal cavity and identify the infection. The bowel loop was gently divided if it was adherent to the inguinal region, and it was examined to rule out the presence of fistulas. If the mesh had been implanted in the preperitoneal space during the previous surgery or if the infection involved the preperitoneal space, the infected mesh was laparoscopically removed as previously reported [7]. Briefly, if an abscess was present, a small incision was made at the lateral margin of the abscess. The pus was completely aspirated, and a pus specimen was sent for culture. The peritoneum was then developed 2 cm above the internal inguinal ring to explore the infected mesh. The mesh was divided away with great care to avoid injury to the bladder, inferior epigastric vessels, and iliac vessels. Partial mesh removal was applied if part of the mesh seemed well incorporated. After thorough irrigation of the preperitoneal space, a drain was inserted. The peritoneal flap was closed with 3/0 absorbable suture in a continuous pattern. An abdominal cavity drain was placed if necessary. An additional open excision was performed if an abdominal wall sinus was present.

On the other side of the abdomen, if the patch had been implanted beneath the spermatic cord or a plug had been implanted during the previous surgery, and if the preperitoneal space was not involved, the infected mesh was removed by open surgery. First, methylene blue was injected into the sinus orifice. The skin, scar tissue, sinus, knot, infected mesh, and blue-stained infected tissue were excised. Likewise, partial mesh removal was applied if part of the mesh seemed well incorporated. The incision was washed repeatedly, and a closed vacuum drain was placed. The scar tissue was restored with 2/0 polypropylene suture, and the subcutaneous tissue and skin were closed with full-thickness suture. In cases involving a large abscess cavity or severe infection, the incision was packed with gauze. After the incision condition had improved, secondary suturing or negative-pressure therapy was applied. Intravenous antibiotics were administered according to the bacterial susceptibility test results. The drainage amount was monitored, and the drain was removed after ultrasonography or CT confirmation.

Follow-up was performed by telephone interviews and outpatient clinic visits. The last follow-up date was 30 June 2022.

Statistical analysis was performed with SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation, and categorical variables are presented as frequency and percentage. Pearson's χ^2 test or Fisher's exact test for categorical variables was used. A P value of < 0.05 was considered statistically significant.

Results

In total, 120 patients with a mean age of 54.4 years (range 13–82 years) were included in this study. The patients comprised 8 women and 112 men. Forty-one patients were overweight and 26 were obese. Thirty-seven patients were smokers, and 10 patients had diabetes. Notably, two patients had a history of sclerosant injection (Table 1).

The most common clinical presentation was a chronic sinus. Two patients had urinary symptoms and underwent preoperative cystoscopy to determine whether mesh erosion into the bladder had occurred. A total of 70.8% of patients had a > 3-month history of chronic infection, and the longest duration of infection was 84 months. The most frequent type of surgery was plug implantation, accounting for 41.6% of the procedures. The most common type of explanted mesh was polypropylene (Table 2).

There were 88 positive cultures. In 55 patients, the cultures tested positive for *Staphylococcus aureus.* Other agents included *Pseudomonas aeruginosa, Escherichia coli,*

Table 1 Patient demographics

	Mean ± SD/ frequency (%)
Gender	
Female	8 (6.7)
Male	112 (93.3)
Age, years	54.4 ± 16.4
Body mass index, kg/m^2	24.8 ± 3.9
< 18.5	4 (3.3)
18.5–23.9	49 (40.8)
24–27.9	41 (34.2)
≥ 28	26 (21.7)
Comorbid conditions	
Tobacco use	37 (30.8)
Diabetes	10 (8.3)
Cirrhosis	4 (3.3)
Immunosuppression	2 (1.7)
History of sclerosant injection	2 (1.7)

Table 2 Mesh infection characteristics

	Frequency (%)
Presentation	
Chronic sinus	102 (85.0)
Mesh extrusion	1 (0.8)
Urinary symptoms	2 (1.7)
Time from postoperative to onset, mo	
< 3	53 (44.2)
≥ 3, < 12	28 (23.3)
≥ 12	39 (32.5)
Time from onset to surgery, mo	
Early infection < 1	11 (9.2)
Delayed infection ≥ 1, < 3	24 (20.0)
Chronic infection ≥ 3, < 12	52 (43.3)
Chronic infection ≥ 12	33 (27.5)
Type of previous hernia	
Primary	110 (91.7)
Recurrence	10 (8.3)
Type of previous repair	
TAPP	30 (25.0)
TEP	3 (2.5)
Flat patch	30 (25.0)
Plug	16 (13.3)
Plug + patch	34 (28.3)
Open preperitoneal	7 (5.8)
Type of mesh	
Polypropylene	78 (65.0)
Polyester	6 (5.0)
Biological mesh	4 (3.3)
Unknown	32 (26.7)

TAPP transabdominal preperitoneal repair, *TEP* totally extraperitoneal repair

Staphylococcus epidermidis, Klebsiella pneumoniae, Streptococcus pneumoniae, and other species. The microbiological findings are shown in Table 3.

Laparoscopic exploration was performed in 108 patients. Forty-two patients underwent laparoscopic adhesiolysis, and eight patients with mesh infection and bowel fistula confirmed by laparoscopic exploration underwent intestinal fistula repair. Infected meshes were removed by the laparoscopic approach in 20 patients and by the open anterior approach in 100 patients. Seventy patients underwent complete removal of the infected mesh, and 50 underwent partial removal. Two patients had iliac vessel injury. The mean operation time was 82.9 ± 37.9 min, and the mean hospital stay was 24.0 ± 12.2 days (Table 4).

The outcomes of mesh removal are presented in Table 5. The patients were divided into two groups according to the type of mesh removal. In the short-term follow-up, the overall postoperative incidence of wound infection was 10.0% (12 cases): 9 patients in the complete mesh removal group and 2 in the partial mesh removal group had a minor wound infection with the need for dressings and antibiotics, and 1 patient in the complete mesh removal group had a wound infection requiring debridement. Other short-term complications included 30 untreated seromas and 3 uninfected hematomas. There was no mortality.

The mean follow-up period was 39.1 months (range 18.7–54.2 months). In the long-term follow-up, four patients developed hernia recurrence at 18, 18, 23, and 34 months after mesh removal, respectively. Two patients experienced mild chronic pain, and oral analgesics were effective. Four patients in the complete mesh removal group and 23 patients in the partial mesh removal group developed a recurrent infection that required a reoperation. There was a statistically significant difference between the two groups ($P < 0.001$).

Table 3 Microbiology of mesh infection

	Frequency (%)
Positive cultures	88 (73.3)
Staphylococcus aureus	55 (62.5)
Pseudomonas aeruginosa	9 (10.2)
Escherichia coli	8 (9.1)
Staphylococcus epidermidis	4 (4.5)
Klebsiella pneumoniae	3 (3.4)
Streptococcus pneumoniae	1 (1.1)
Others	8 (9.1)
Negative cultures	32 (26.7)

Table 4 Features of surgery

	Mean ± SD/ frequency (%)
Laparoscopic exploration	108 (90.0)
Mesh removal method	
Laparoscopic mesh removal	20 (16.7)
Previous TAPP repair	20 (16.7)
Open mesh removal	100 (83.3)
Previous TAPP and TEP repair	13 (10.8)
Previous flat patch repair	30 (25.0)
Previous plug repair	50 (41.7)
Previous open preperitoneal repair	7 (5.8)
Mesh removal type	
Complete	70 (58.3)
Partial	50 (41.7)
Incision management	
Stage I suture	105 (87.5)
Packing with gauze	15 (12.5)
Operation time, min	82.9 ± 37.9
Blood loss, mL	15.9 ± 23.3
Hospital stay, days	24.0 ± 12.2

TAPP: transabdominal preperitoneal repair

TEP: totally extraperitoneal repair

Table 5 Analysis of removal type for short- and long-term outcomes

	Complete removal $n=70$ (%)	Partial removal $n=50$ (%)	*P* value
Minor wound infection	9 (12.9)	2 (4.0)	0.181
Wound infection requiring debridement	1 (1.4)	0 (0)	1.000
Seroma	19 (27.1)	11 (22.0)	0.521
Hematoma	2 (2.9)	1 (2.0)	1.000
Hernia recurrence	2 (2.9)	2 (4.0)	1.000
Chronic pain	2 (2.9)	0 (0)	0.510
Recurrent infection	4 (5.7)	23 (46.0)	< 0.001

Discussion

The Centers for Disease Control and Prevention has issued an surgical site infection (SSI) criterion that distinguishes superficial incisional SSI, deep incisional SSI, and organ/space SSI [8]. Mesh infections should be distinguished from superficial incisional SSI, which tend to occur in the early postoperative period and do not involve the mesh. In contrast, mesh infections tend to present after a delayed period following mesh repair and require mesh removal [9, 10].

The clinical manifestations of mesh infection are mainly local swelling and pain, lumps, and sinus tract secretions; some patients also develop fever [11]. More frequently, mesh infections tend to present in a more indolent manner with chronic, persistent, or recurrent signs and symptoms [9]. The typical manifestation is a chronic sinus, which is painless and remains unhealed for a long time. There is no obvious acute inflammation in the surrounding skin. In addition, if mesh migration occurs, it predominantly occurs into the urinary bladder; attention should thus be paid to the presence of painless hematuria, recurrent urinary tract infections, and bladder calculi [12, 13]. In the present study, 70.8% of patients had a > 3-month history of chronic infection, and almost one-third of the patients presented ≥ 1 year from the time of hernia repair. This delayed presentation is consistent with the indolent nature of many mesh infections and is likely due to the long duration from contamination to the development of a biofilm; this allows bacterial proliferation because of suppressed immune function and antibiotic penetration [14].

In the present study, the cultures tested positive in 88 patients, and 62.5% of these cultures were positive for *Staphylococcus aureus*. This is similar to the results of pathogen culture reported in the literature [15]. A bacterial biofilm (commonly involving *Staphylococcus aureus*) that forms on the surface of mesh results in a low detection rate of bacterial culture [9, 15]. Thus, the diagnosis of mesh infection is based on the clinical presentation. Ultrasound, CT, and contrast fistulography can also help to establish the diagnosis. It is better to perform CT after injection of iodinated contrast media in the sinus because this technique can more clearly show the size of the abscess; the length, depth, and direction of the sinus; and whether the bowel and bladder are involved.

The risk factors for mesh infection are multifactorial and include both patient-related systemic factors and surgical local factors. Sereysky et al. [16] reported that diabetes, a body mass index of ≥ 35 kg/m^2, and current smoking are significantly associated with an increased risk of SSI after initial open repair of a reducible inguinal hernia in adults with clean surgical sites. Chatzimavroudis et al. [17] reported that obesity is a lifetime risk factor for mesh infection after groin hernia repair. A common local factor is the occurrence of dead space between the mesh and the host tissues, a condition that prevents incorporation of the mesh. Such dead space may develop secondary to mesh wrinkles, the use of microporous mesh, fixation of the mesh with nonabsorbable multifilament sutures, fixation of the mesh over previous mesh to treat recurrence [18], and improper use of medical glue [11]. In a registry-based multicenter study of 21,976 cases from the French Hernia-Club, Christou et al. [19] proposed that the mesh

type (polypropylene or polyester) and surgical technique (open or laparoscopic) did not affect the SSI rate.

A few recent small-scale studies have proposed similar approaches to the treatment of mesh infection [7, 11, 15]. However, no consensus has been established regarding the optimal timing of mesh removal. According to our experience, conservative treatment such as dressing changes and drainage should be initiated first, and mesh removal should be performed at least 3 months after the onset of infection. During this time, the uninfected part of the mesh will continue to become incorporated into the surrounding tissue while the infected part of the mesh will separate from the tissue because of purulent exudate, making mesh removal easier. In this study, laparoscopic exploration was performed in 108 patients. The advantages of laparoscopic exploration are the ability to identify whether the infection involves the internal organs and to separate adhesions in the groin area. In patients who have undergone previous repair with a flat patch and plug, if the mesh infection is complicated by a sinus but does not involve the internal organs, methylene blue should be injected into the sinus orifice to mark the scope of infection [15], and the mesh should then be removed by open surgery. For patients who have previously undergone transabdominal preperitoneal hernia repair and totally extraperitoneal hernia repair, the mesh is usually removed by laparoscopic surgery. Laparoscopy provides better visualization for identification of important anatomical structures. Furthermore, the anterior approach is left intact to facilitate the repair of future recurrences [7]. Surgeons face a dilemma in treating patients with a history of open preperitoneal mesh placement: they must decide whether to remove the mesh by an open or laparoscopic approach according to whether the infection has penetrated the peritoneum and whether a sinus is present. In the present study, all seven patients who had previously undergone open preperitoneal mesh repair were treated by an open approach because of the combination of a sinus and intact peritoneum.

Most researchers have concluded that complete removal of the infected mesh and the surrounding infected tissue is effective. In a study of 15 patients with chronic mesh infection following abdominal wall hernia repair, Chung et al. [20] demonstrated that most patients who had undergone partial excision of the infected mesh continue to have problems with a discharging sinus. This can be due to small fragments of mesh left behind at the time of the original operation. In our study, there was a significant difference in the incidence of recurrent infection between patients who underwent complete and partial mesh removal ($P < 0.001$). A total of 23 (46.0%) patients who underwent partial mesh removal developed recurrent infection. In fact, it is often difficult to completely remove the infected mesh, especially the part that has become well incorporated into the surrounding tissue. It is a great challenge for surgeons to remove the mesh while avoiding injury to important structures. Success depends on the knowledge of experienced hernia experts with respect to previous repair methods and materials, their proficiency in the anatomy of the inguinal region, and their accurate assessment of the scope of infection.

After the infected mesh is removed, using synthetic mesh simultaneously in the setting of contamination or infection is considered an absolute contraindication. However, Birolini et al. [18] reported that using onlay repair with polypropylene mesh can prevent hernia recurrence and has an acceptable incidence of postoperative acute infection. In fact, Rehman el al. [21] found that hernia recurrence following removal of an infected mesh is not common. After prosthetic mesh implantation, inflammatory cell infiltration occurs, and fibroblast infiltration gradually replaces the inflammatory cells through the mesh pores. The mesh incorporates into the surrounding tissue by fibrous infiltration and neofascia formation [15]. Therefore, the strength of a mesh repair lies in the fibrous reaction evoked within the transversalis fascia by the prosthetic material rather than in the physical presence of the mesh itself [22].

The best treatment of mesh infection is prevention. Adequate preoperative preparation, a standardized aseptic surgical operation, and strict indications for mesh implantation are vital. Additionally, the use of antibiotics prophylaxis is recommended when open mesh repair is performed in a high-risk environment [1]. Biologic mesh has been found to be of value in certain hernia repairs because of its ability to resist infection [5], but there is a lack of evidence to support its use in patients with chronically infected synthetic meshes [20]. In 2010, a framework was developed to grade hernias for identification of patients who may benefit from the use of a biologic mesh in reducing the risk of infection [23]. Patients with grade 1 hernias have no history of wound infection. Patients with grade 2 hernias include those with comorbidities such as smoking, obesity, diabetes, immunosuppression, and chronic obstructive pulmonary disease. Patients with grade 3 hernias have potential contamination-related factors such as the presence of a nearby stoma, violation of the gastrointestinal tract, or a history of wound infection. Patients with grade 4 hernias have active infection, specifically infected mesh and wound dehiscence [23]. Grade 3 and 4 hernias are suitable candidates for use of biologic mesh [23]. Further high-quality prospective research trials are needed to fully assess the clinical value [5].

In conclusion, mesh infection after inguinal hernia repair is one of the most difficult and complex complications. Systematic individualized treatment by experienced experts based on the patient's previous repair technique, implanted mesh, and physical condition is recommended. The risk factors for mesh infection are multifactorial. The most reliable way to treat mesh infection is to remove the mesh as completely as possible. According to our experience, mesh

removal should be performed at least 3 months after the onset of infection. Laparoscopic exploration should be performed to clearly identify the intra-abdominal condition. It is not safe to implant a new mesh, either synthetic or biologic, after the infected mesh has been removed. Based on our data, neither short- nor long-term complications following removal of an infected mesh are common. However, larger-scale studies with longer follow-up are required.

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Data availability Qualitative interview data will not be shared in order to protect the identity of the study participants.

Declarations

Conflict of interest The authors declare no conflict of interest.

Ethical approval For this type of study ethical approval is not required.

Human and animal rights This article does not contain any studies with human participantsperformed by any of the authors.

Informed consent For this type of study formal consent is not required.

References

1. Hernia Surge Group (2018) International guidelines for groin hernia management. Hernia 22:1–165. https://doi.org/10.1007/s10029-017-1668-x
2. Poelman MM, van den Heuvel B, Deelder JD et al (2013) EAES Consensus Development Conference on endoscopic repair of groin hernias. Surg Endosc 27:3505–3519. https://doi.org/10.1007/s00464-013-3001-9
3. Li S, Xiao H, Yang L et al (2019) Electrospun P(LLA-CL) nanoscale fibrinogen patch vs porcine small intestine submucosa graft repair of inguinal hernia in adults: a randomized, single-blind, controlled, multicenter, noninferiority trial. J Am Coll Surg 229(541–551):e1. https://doi.org/10.1016/j.jamcollsurg.2019.08.1446
4. Guillaume O, Pérez-Tanoira R, Fortelny R, Redl H, Moriarty TF, Richards RG, Eglin D, Petter Puchner A (2018) Infections associated with mesh repairs of abdominal wall hernias: are antimicrobial biomaterials the longed-for solution? Biomaterials 167:15–31. https://doi.org/10.1016/j.biomaterials.2018.03.017
5. Meagher H, Clarke Moloney M, Grace PA (2015) Conservative management of mesh-site infection in hernia repair surgery: a case series. Hernia 19:231–237. https://doi.org/10.1007/s10029-013-1069-8
6. Berrevoet F, Vanlander A, Sainz-Barriga M, Rogiers X, Troisi R (2013) Infected large pore meshes may be salvaged by topical negative pressure therapy. Hernia 17:67–73. https://doi.org/10.1007/s10029-012-0969-3
7. Yang H, Liu Y, Chen J, Shen Y (2019) The management of mesh infection after laparoscopic inguinal hernia repair. Surg Laparosc Endosc Percutan Tech 29:40–42. https://doi.org/10.1097/SLE.0000000000000614
8. Campwala I, Unsell K, Gupta S (2019) A comparative analysis of surgical wound infection methods: predictive values of the CDC, ASEPSIS, and Southampton Scoring Systems in evaluating breast reconstruction surgical site infections. Plast Surg (Oakv) 27:93–99. https://doi.org/10.1177/2292550319826095
9. Akyol C, Kocaay F, Orozakunov E et al (2013) Outcome of the patients with chronic mesh infection following open inguinal hernia repair. J Korean Surg Soc 84:287–291. https://doi.org/10.4174/jkss.2013.84.5.287
10. Ito H, Matsumoto K, Terauchi T, Kimata M, Lefor AK, Shinozaki H (2021) Delayed mesh infection after inguinal hernia repair: a case report. J Surg Case Rep 2021:rjab399. https://doi.org/10.1093/jscr/rjab399
11. Luo Y, Wang C (2021) The clinical characteristics and treatment of mesh infection after laparoscopic inguinal hernia repair: two cases report and literature review. Asian J Surg 44:1449–1452. https://doi.org/10.1016/j.asjsur.2021.07.062
12. Mulleners G, Olivier F, Abasbassi M (2019) A minimally invasive treatment of an asymptomatic case of mesh erosion into the caecum after total extraperitoneal inguinal hernia repair. Acta Chir Belg 119:176–181. https://doi.org/10.1080/00015458.2017.1419918
13. Li J (2020) Total extraperitoneal (TEP) management of mesh erosion into bladder following transabdominal preperitoneal inguinal hernia repair (TAPP). Hernia 24:205–208. https://doi.org/10.1007/s10029-018-1871-4
14. Arnold MR, Kao AM, Gbozah KK, Heniford BT, Augenstein VA (2018) Optimal management of mesh infection: evidence and treatment options. Int J Abdom Wall Hernia Surg 1:42–49
15. Wang D, Fu Y, Liu Q, Chen J (2021) Maximal infected mesh removal with methylene blue injection for mesh infection after inguinal hernia repair. Surg Infect (Larchmt) 22:347–352. https://doi.org/10.1089/sur.2020.133
16. Sereysky J, Parsikia A, Stone ME, Castaldi M, McNelis J (2020) Predictive factors for the development of surgical site infection in adults undergoing initial open inguinal hernia repair. Hernia 24:173–178. https://doi.org/10.1007/s10029-019-02050-3
17. Chatzimavroudis G, Papaziogas B, Atmatzidis S, Atmatzidis K (2014) Obesity as a lifetime risk factor for mesh infection after groin hernia repair. Ann Surg 259:e89. https://doi.org/10.1097/SLA.0000000000000317
18. Birolini C, de Miranda JS, Utiyama EM, Rasslan S (2015) A retrospective review and observations over a 16-year clinical experience on the surgical treatment of chronic mesh infection. What about replacing a synthetic mesh on the infected surgical field? Hernia 19:239–246. https://doi.org/10.1007/s10029-014-1225-9
19. Christou N, Ris F, Naumann D, Robert-Yap J, Mathonnet M, Gillion JF, Members C-H (2022) Risk factors for surgical site infection after groin hernia repair: does the mesh or technique matter? Hernia 26:233–242. https://doi.org/10.1007/s10029-021-02512-7
20. Chung L, Tse GH, O'Dwyer PJ (2014) Outcome of patients with chronic mesh infection following abdominal wall hernia repair. Hernia 18:701–704. https://doi.org/10.1007/s10029-014-1277-x
21. Rehman S, Khan S, Pervaiz A, Perry EP (2012) Recurrence of inguinal herniae following removal of infected prosthetic meshes: a review of the literature. Hernia 16:123–126. https://doi.org/10.1007/s10029-011-0873-2
22. Fawole AS, Chaparala RP, Ambrose NS (2006) Fate of the inguinal hernia following removal of infected prosthetic mesh. Hernia 10:58–61. https://doi.org/10.1007/s10029-005-0031-9
23. Ventral Hernia Working Group, Breuing K, Butler CE, Ferzoco S, Franz M, Hultman CS, Kilbridge JF, Rosen M, Silverman RP, Vargo D (2010) Incisional ventral hernias: review of the literature and recommendations regarding the grading and technique of

repair. Surgery 148:544–558. https://doi.org/10.1016/j.surg.2010.01.008

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