

## Original Article

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# Prevention of patch infection after abdominal external hernia repair

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**Abstract:** External abdominal hernia is a common clinical disease. The application of hernia patch is a breakthrough in the treatment of external abdominal hernia. However, complications such as patch infection need to be solved urgently. Patch infection markedly prolongs the hospitalization time and increases the medical expenses of patients. At present, a standard method for the diagnosis, treatment, and prevention of patch infection remains to be developed. This paper summarizes the literature in recent years to explore the research progress in the prevention and treatment of patch infection.

**Keywords:** Abdominal external hernia, Tension-free repair, Patch infection

Abdominal external hernia is a common external disease classified into different types, including inguinal, umbilical, and incisional. The application of hernia patch is a breakthrough in the treatment of abdominal external hernia. This approach is widely recognized in clinical practice because it can markedly reduce the recurrence rate of hernia. Tension-free repair is the principal method of surgical treatment to abdominal external hernia. However, complications such as patch infection, seroma, intestinal adhesion, and intestinal obstruction [1-2] are clinical problems that need to be solved urgently. Infection of hernia patch, being a foreign matter, cannot be treated using conservative approaches. Clinicians should determine whether the patch needs to be removed and how to repair the abdominal wall defects following its removal. Therefore, the prevention and treatment of patch infection warrant further studies. Accordingly, this paper summarizes the literature in recent years about the prevention and treatment of patch infection after abdominal external hernia repair.

## 1 Risk factors of patch infection

The specific mechanism underlying patch infection remains unclear to date because of its complex origin. Factors that increase the risk for patch infection include patients, chronic obstructive pneumonia, diabetes, morbid obesity, malnutrition, history of coronary heart disease, smoking history, immunodeficiencies, and American Society of Anesthesiologists score  $\geq 3$  [3-6]. In addition, recent studies have discovered other factors related to the occurrence of patch infection. These factors are discussed below.

- [1]. The pore size of the patch material and the structure of the patch can affect the joint between the patch and host tissue. Polypropylene patch has a large pore size ( $>75 \mu\text{m}$ ), allowing fibroblasts to pass through and bind with tissues. However, the pore size of polytetrafluoroethylene patch is small ( $<10 \mu\text{m}$ ), preventing fibroblasts to pass through. This relative impermeability reduces the risks for tissue adhesion and viscera erosion but increases the incidence of local seroma. Polytetrafluoroethylene patch allows bacteria with a diameter of approximately  $1 \mu\text{m}$  to pass through but not macrophages and multinuclear leukocytes with a diameter of about  $10 \mu\text{m}$ , which increases the risks of infection [7].

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Compared with the patch of a single fiber structure (polypropylene patch), the patch of multiple fiber structures (polytef patch) has a higher rate of infection because of its larger surface area for bacterial adhesion [3]. The gaps between the woven fibers not only provide a hiding area for bacteria but also serve as a deterrent to immune cells [7]. Thus, the application of multiple stitches to fix the patch may increase the risk of patch infection.

- [2]. Infection of the effusion around the patch may be secondary to the sterile effusion around the patch. Bacteria in the blood circulation cannot colonize the well-organized patch but can enter the fluid around the patch, leading to infection [7]. Upon seroma formation, repeated tapping may also increase the risk of patch infection [2]. In addition, if the intraoperative hemostasis is not strict, the accumulated blood around the patch can become a good culture medium for bacterial growth.
- [3]. Superficial infection of the surgical site usually occurs in the early postoperative period without involving the patch [8]. However, failure to treat superficial infection in a timely manner can cause the infection to gradually develop deeper and penetrate the underlying patch, especially the patch placed before the muscle [7].
- [4]. By theory, repeated disinfection of the contaminated hernia patch after adequate disinfection will not increase the risk of infection. However, the resterilized patch may inhibit the growth of fibroblasts and affect the binding of the patch to host tissue [3], which can result in complications, such as local effusion, and increase the risks for patch infection.

## 2 Clinical manifestations of patch infection

The location of patch infection is usually deep and tends to be chronic. The patients mostly could not be cured by conservative treatment methods, such as dressing change and antibiotics, in local hospitals and then transfer to superior hospitals. Liu *et al.* reviewed 22 cases of patch infection after external abdominal hernia repair and found that the disease course lasts 3–14 months [1]. Clinical manifestations are mostly caused by local inflammatory reactions, including surgical incision purulent discharge, local swelling, sinus tract formation, and chronic pain in the surgical site [3]. The formation of a honeycomb abscess at a distant site may also result from the shedding of bacterial clumps and cause serious complications, such as bacteremia [9].

The time span of patch infection after operation is large. The occurrence time has bimodal distribution, and the patch infection was suggested to be divided into early infection and late infection within 6 months after surgery. The two types differ in clinical manifestations. Early infection is mostly manifested as surgical incision purulent secretions, whereas late infection is mostly manifested as erythema in the original incision; in addition, the pain in the surgical site is more serious in late infection than in early infection [10].

## 3 Bacteriological features of patch infection

The most common bacteria that cause a patch infection is regarded as the methicillin-resistant *Staphylococcus aureus* [11] or methicillin-resistant *Staphylococcus epidermidis*.

*S. epidermidis*,  $\beta$ -hemolytic *Streptococcus*, *Enterococcus*, and anaerobic bacteria are also observed in the patch infection [12].

Bacterial adhesion, bacterial proliferation, and biofilm formation are three essential steps in patch infection. As a foreign matter, the patch lowers the threshold of the bacteria needed for infection. Biofilm is formed through the proliferation after the bacteria are adhered to the patch, which can enhance the resistance of the bacteria to antibiotics, evade host immunity, and lead to negative results of common bacterial culture [3]. Through confocal microscopy, Kathju *et al.* [9] directly discovered the bacterial biofilm from the patch removed from surgery and confirmed that the formed bacteria biofilm is heterologous and is a combination of microorganisms.

## 4 Diagnosis of patch infection

Owing to the lack of a clear definition of patch infection, its diagnosis standard has a large opposition. The clinical diagnosis of patch infection is mainly based on the medical history and clinical manifestations of patients, such as local erythema, swelling, and purulent secretions [6]. Laboratory tests also showed that an increase in neutrophil count caused by patch infection accelerates an increase in C-reactive protein content. Imaging examinations, such as ultrasound and computed tomography (CT), and local effusion puncture culture can help diagnose patch infection [3].

Patch infection and superficial infection of surgical site, which have different principles of treatment, should be distinguished to achieve an accurate diagnosis of patch infection. The latter usually does not invade the patch.

Full debridement can be cured without removing the patch [8].

## 5 Treatment strategies of patch infection

The treatment of patch infection should follow the principle of individualization, and the treatment plan should be determined according to the patch type, hernia type, surgical method, and clinical treatment experience [6].

### 5.1 Conservative treatment

Conservative treatment is ideal because it retains the patch and reduces the recurrence risk of hernia. However, biofilm formation increases the resistance of the bacteria to antibiotics and the host immune system, thereby complicating the treatment of patch infection by using conservative approaches.

At present, commonly used conservative treatment measures include systemic application of antibiotics, local dressing, drainage of pus, and incision washing [3]. Recent studies have reported the application of vacuum-assisted closure to treat patch infection [1].

Vacuum-assisted closure has a clinical application value because it can continuously attract effusion between tissues, reduce bacterial load, and induce tissue regeneration [6]. However, its effectiveness in the treatment of patch infection needs further research. In addition, the success rate of conservative treatment is directly related to the type of implant patch [6]. Compared with polytef patch, the polypropylene patch is more likely to be preserved through conservative treatment [3]. In addition, patch infection after recurrent hernia repair is difficult to be cured through conservative treatment [6].

Therefore, the conservative treatment of hernia repair should be carefully selected based on the patient's situation and treatment experience. When long-term conservative treatment still fails, surgical treatment should be considered.

### 5.2 Surgery to remove the patch

Surgery to remove the patch is still the most common clinical treatment of patch infection. However, after the patch is removed, the patient may still face hernia recurrence, which requires further surgical treatment. The traditional treatment regimen requires multiple surgeries, including removing the patch for infection control and placing the patch again after surgery. This treatment not only extends hospital stay and increases the burden of care but also greatly increases the suffering of patients [7]. For the patch infection after inguinal hernia repair, local fibrous scar tissue is formed due to the inflammatory reaction after patch implantation. If enough fibrous scar tissue remains in the region, removal of the patch will not lead to hernia recurrence [8]. Different types of patch form fibrous scar tissue at different times.

As for the patch infection after incision hernia surgery, the recurrence rate of hernia can reach as high as 23% after the patch is removed [11]. Therefore, repairing the abdominal wall defect with the simultaneous placement of the patch is a more reasonable surgical method. However, many scholars focused on the choice of materials for the repair of abdominal wall defects. Reuse of synthetic patch repair increases the risk of patch reinfection, which often leads to the failure of surgery.

A recent study has used human acellular dermal matrices (HADMs) for repairing [1]. HADMs feature strong anti-infection ability and are suitable for patients at a high risk of infection [13]. However, HADMs have few sources, are expensive, and are difficult to promote [1]. The application of component separation technique can also reduce the recurrence rate of hernia [1,3].

## 6 Preventions of patch infection

Patch infection is difficult to treat and probably requires reoperation, which is expensive and severely affects the life quality of patients. Therefore, the prevention of patch infection obtains preferable clinical results. Many strategies and measures have been employed to reduce the occurrence rate of patch infection.

### 6.1 Prophylactic application of antibiotic herniorrhaphy as a cleaning surgery

The prophylactic use of antibiotics is controversial. In view of orthopedic implant experience, many scholars recommended the use of antibiotics to prevent infection. However, a prospective study of 395 patients in recent years has shown that the preoperative prophylactic use of cefazoline does not reduce the incidence of infection [14]. In addition, immersion treatment with vancomycin before the patch implantation cannot significantly improve the postoperative infection rate [5]. In view of the relatively low incidence of patch infection and bacterial resistance, routine application of antibiotics to prevent infection before hernia repair is not advisable. For patients at a high risk of infection, such as those with relapse hernia, advanced age, immunodeficiencies, long-time surgery, and emergency surgery, antibiotics can be considered to prevent infection [14].

### 6.2 Selection of patch

The value of patch selection to prevent infection can be expected due to the influence of factors, such as patch aperture size and structure, on patch infection after surgery. At present, the patch of different materials is used in clinic, and the commonly used materials are polyester patch, polypropylene patch, polytef patch, and composite materials [15]. Compared with other patches, the polytef patch has a higher infection rate, which probably is related to its undersized patch aperture. Brown *et al.* reported that in 176 cases of incisional hernia repair, the infection rate of polytef patch was 14%, whereas that of other patches was only 2.2% [15]. Polypropylene patch also has a lower infection rate during potentially contaminated hernia repair [16]. In addition, some patches were coated with antibacterial coatings (such as silver and chlorhexidine) to reduce bacterial adhesion *in vitro*, but whether this procedure decreases infection rate has yet to be proven in clinical applications [15].

### 6.3 Prevention of seroma

Seroma is a potential risk for graft infection [17]. Therefore, the prevention of seroma is also of great significance to reduce patch infection. Preoperative discontinuation of anticoagulant is the standard operation to avoid coiling of patch.

Measures such as strict hemostasis and drainage tube placement during local cavity formation can reduce the incidence of seroma [18] and reduce the risks of patch infection.

## 6.4 Strict aseptic operation

Patch infection is mostly caused by bacterial contamination during implantation. The bacteria may come from the epidermis of the patient or from the medical staff or medical instruments. In a few cases, the bacteria may be contaminated by the unqualified patch or the sterilization of the patch package [3]. Therefore, strict aseptic operation and sufficient skin preparation can reduce the risk of bacterial contamination during implantation and thus decrease the occurrence rate of patch infection. In recent years, many reports have mentioned that laparoscopic surgery is of lower infection rate than open surgery, possibly because of the less contact of the patch with the surgeon and the skin of the patients [15, 19].

## 6.5 Timely treatment of the superficial infection at the surgical site

Although the superficial infection at the surgical site does not involve the patch, a risk of further development of patch infection still exists. Clinically, superficial infection has not received considerable attention because of its relatively high incidence and relatively mild symptoms. In view of its potential risk of inducing patch infection, superficial infection should be timely and actively treated, and adequate debridement drainage of local effusion combined with antibiotics is usually necessary [7].

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