Use of chitosan wound dressing for the treatment of surgical site infection: a case report

Abstract: Surgical site infections (SSIs) are treated using topical antiseptics and systemic antibiotics, but some cases are unresponsive to such regimens. This case study reports the effective healing of an SSI by a chitosan wound dressing (MaxioCel; Axio Biosolutions Private Limited, India) in a 63-year-old female patient. The patient presented with an infected, hard-to-heal wound in the abdominal region, developed after a hernia surgery, and was initially treated with standard procedures. However, due to the continuous progression of infection, a highly absorbent, bioactive microfibre dressing was selected for the treatment and was continued for two months with alternate-day dressing changes. After 60 days of treatment, wound healing was observed, along with remission from the infection, as well as reduction in exudate level and pain. The use of chitosan wound dressing in management of hard-to-heal infected wounds provides efficient remission of SSI and a faster healing rate.
Declaration of interest: The authors have no conflicts of interest.

antimicrobial • chitosan • chronic wound • hard-to-heal wound • MaxioCel • surgical site infection • wound dressing • wound • wound care • wound healing

Surgical site infection (SSI) is the most common hospital-acquired infection in Europe[1] and is even more common in India.[2] The numbers indicate an incidence of 23–38% in India compared with 0.5–15% in Europe. The incidence of SSI is generally influenced by factors such as pre- and post-operative care, the theatre environment and the type of surgery. The World Health Organization (WHO) recommends simple hand preparation with soap alone as adequate in preventing SSI.[3] Even though strong precautions are taken in the pre-operative and theatre environment, it is also important to have patient engagement in post-operative care of surgical wounds.[4]

An acute wound is acquired as a result of an incision or trauma and usually heals in a timely and orderly manner. After injury, the healing process consists of four major phases: the initial and late inflammatory phases, the proliferative phase and the remodelling phase.[5] As exposed wounds are prone to infection they are generally cleansed or debrided before treatment. Traditionally, wounds were treated by protecting them against infection and leaving them for natural mechanisms to take charge of healing. However, in recent years there have been many advances in the area of wound care.

The new generation of wound care dressings not only act as a barrier to microbes but also possess advanced antimicrobial agents.[6] However, use of antimicrobial agents increases the chance of development of drug resistance and is a serious issue when treating infected wounds. Antibiotic resistance is commonly seen with amoxyl–clavulanate, ceftriaxone and cloxacillin.[7]

Materials used for the treatment of wounds range from honey to highly advanced nanoparticle-containing dressings. However, the majority of wound care uses hydrogel technology, where the biomaterials absorb exudates and conform to the contour of the wound. It is also helpful to use dressings possessing inherent antimicrobial properties, such as chitosan-based wound dressings. Since the antibacterial properties of chitosan are based on ionic interaction and physical destruction of bacterial cell wall, it is unlikely to cause resistance on long-term use of the dressing.[8]

Among the various dressings used for wound care, chitosan-based dressings are gaining popularity.[9] Chitosan-incorporated dressings are particularly useful in wound management because of their unique properties, such as biocompatibility, biodegradability and non-toxic nature, along with bacteriostatic and fungistatic properties. Chitosan dressings have been successfully used to treat wounds of varying sizes and aetiology. One such advanced product based on this material is MaxioCel (Axio Biosolutions Private Limited, India). The mechanism of chitosan action in wound healing has been described as due to its stimulation of the growth of macrophages, fibroblasts and capillaries, as well as its antibacterial properties due to its cationic nature.[8] The main advantages of using chitosan dressings in wound healing are due to its antimicrobial, wound regeneration, pain alleviation and scar reduction properties.[10] Chitosan is generally obtained from shellfish; and so it is contraindicated in patients with a shellfish allergy.

In this paper, the authors present a unique case of management of an infection in a hard-to-heal

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abdominal wound that developed post-surgical intervention for hernia. The case describes effective use of bioactive microfibre dressing for wound healing when conventional methods had failed to provide a successful outcome.

Case

A 63-year-old female patient with a history of hernia was admitted at Paras Hospital, Gurgaon, Haryana, India due to a hard-to-heal wound on her abdomen in the umbilical area. The wound had been present for approximately one month, with previous localised treatment involving wound dressing with povidone-iodine solution. At the time of hospitalisation, the patient had a pain score of 7 out of 10 on a visual analogue scale (VAS) where '0' represented no pain and '10' represented the worst pain imaginable.

As part of the wound management methods, debridement of the wound area was performed to manage exudate levels and infection, and to maintain the moisture level of the wound. Debriding also prevents the spread of infected tissue, hence enabling the rate of recovery of the wound to increase.

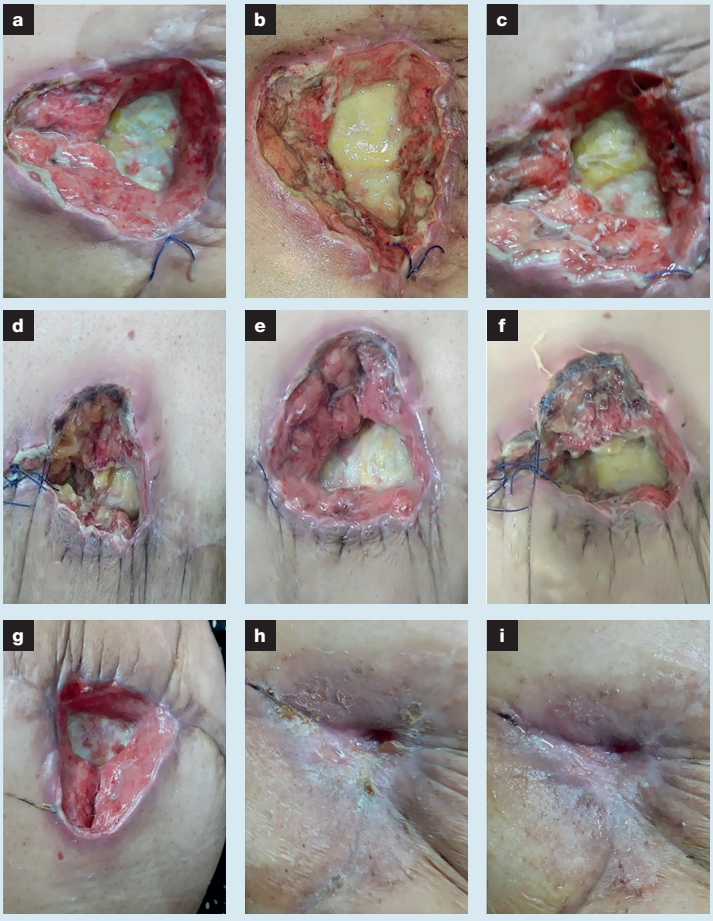
As part of the previous treatment regimen, a povidone-iodine solution-soaked gauze had been applied to prevent infection on the wound area, and surgical debridement had been performed, due to persistent infections, along with fluid treatment and other supportive treatments to manage the patient's condition. Previous treatment of hernia had included surgical repair through the anterior approach, using an incision at the umbilicus.

At the time of admission, the wound area was 60×50mm with a depth of 40mm. The wound had high exudate levels, with 80% sloughy and 20% necrotic tissue, and the patient complained of moderate pain at the wound site (Fig 1).

Throughout the course of treatment, chitosan dressings were used and changed on alternate days, with a total of 30 dressings used (10×10cm). Due to the previous lack of improvement in wound healing with use of standard povidone-iodine dressings, this advanced bioactive microfibre dressing was used to manage the complications of this hard-to-heal wound infection. It is a highly absorbent wound dressing which has haemostatic, antimicrobial and pain relief properties, as well as the property of managing its exudate.

During 60 days of treatment with the new-generation dressing (Fig 1), healing of the wound had progressed significantly, despite the complex conditions of the wound (high level of exudate, infection, depth and pain). The results achieved with the use of a chitosan dressing were reduction in pain and exudate levels, along with reduction of infection. The ease of application and removal of the dressing and comfort level of the patient with use of this dressing were found to be excellent. The patient reported that the dressing was comfortable to wear. The wound closed completely after 60 days of treatment.

Fig 1. Wound healing progression during the use of chitosan dressings. The wound area can be seen to be gradually reducing with these dressings, which were changed on alternate days for 60 days. The images clearly show the ability of this dressing to combat surgical site infections. The dressing was able to absorb exudates and helped in hastening the normal wound healing process: 1 day **(a)**; 8 days **(b)**; 16 days **(c)**; 24 days **(d)**; 32 days **(e)**; 40 days **(f)**; 48 days **(g)**; 54 days **(h)**; 60 days **(i)**



Ethics

The patient gave written consent for the case details and photographs to be published. Because the dressing was already on the market and approved for wound healing, there was no requirement to gain ethical approval.

Discussion

Incisional hernia is mostly caused by abdominal surgery. Despite advances in the prevention and treatment of infection during surgery, and the use of suture materials that have reduced the incidence of incisional hernias, they still occur in 11–20% of cases after abdominal surgery.[11] Treatment methods for abdominal hernia include the simple closure method and the tension-free method using a mesh, a choice which depends on the diameter of the hernia orifice.[12] The tension-free/mesh method has been widely used, but an important complication is mesh infection.[13] Important advances in medical technology have led to the production of

relatively inert and biocompatible surgical meshes. However, surgical meshes can trigger various responses when implanted in the human body, including inflammation (foreign body reaction), fibrosis, calcification, thrombosis and infection. Meshes made of non-absorbable polymers have been used most frequently in clinical practice. Recent studies have indicated that the weight of the mesh and its pore size also have a bearing on mesh-related reactions in the body.[14]

The patient presented with infection on the surgical site within a week and the wound grew larger within a month. The povidone-iodine dressings did not resolve the problem in this patient's case, and so the authors switched to the advanced wound care dressing based on chitosan. It comprises a biopolymer chitosan, which is polycationic at pH <6, and it readily interacts with negatively charged molecules, such as proteins, anionic polysaccharides, fatty acids, bile acids and phospholipids. The dressing used is an advanced wound dressing which works on the principle of bioactive microfibre gelling technology. It consists of 100% chitosan. It absorbs excess exudates and creates an ideal environment for wound healing. Upon contact with wound exudates, it transforms into a cohesive gel matrix that conforms to the wound bed, maintains optimal moisture balance, eliminates empty spaces and provides a soothing effect at the wound site.

The wound was infected and had been present for the previous month on the surgical site when the chitosan dressing application was initiated. Chitosan possesses broad-spectrum antibacterial activity and has been shown to be active not only in soluble form but also in insoluble forms, such as nanoparticles and in wound dressings.[15] A chitosan dressing is converted into a gel after absorbing moisture. This forms a three-dimensional polymer network that can absorb large amounts of water and is moist, flexible and soft, conforming to the contours of the wound. During contact with the wound, the gelling chitosan dissolves slowly in the microenvironment, releasing chitosan molecules which act as antibacterial agents, preventing bacterial growth and reducing infections in the wound. The antibacterial properties of chitosan in solution are well described in the literature.[15–17] Apart from having antimicrobial properties it is also important to have the ability to enhance the healing rate of the wound in an ideal dressing. Chitosan helps in the wound healing process by stimulating inflammatory cells, macrophages and fibroblasts during the inflammatory phase of the wound healing process.[15]

In our case, the patient had developed an infection at the suture line, causing multiple challenges to manage the rate of healing of the wound; however, the chitosan dressing showed remarkable results for management of exudate, infection and pain. Chitosan has also proven to be an effective analgesic and literature reports suggest that chitosan absorbs the hydrogen ions at the inflammatory site and reduces the pain experienced by the patient.[16,18] The dressing was found to be conformable and exhibited an antimicrobial barrier as it not only prevented the spread, but also the onset of any further infection. The results with the use of chitosan dressing showed a faster rate of wound healing as compared to previously used povidone-iodine dressings.

Conclusion

This case represents the advantages of chitosan-based advanced wound care dressing in surgical wounds and suggests that the use of chitosan-based dressings can be helpful in preventing complications and promoting healing in post-surgical wounds. The chitosan dressing was started one month after the surgery. At this time the wound was already infected and inflamed. The exudates and the presence of necrotic tissue are other factors to be considered in the use of these dressings. After chitosan dressing use the wound closed within 60 days. In our opinion, chitosan dressings are best suited for heavily exudating wounds irrespective of their stage. JWC

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Reflective questions

- How do chitosan dressings help with surgical site infection?
- How is a chitosan dressing useful in a hard-to-heal wound?
- What is the role of chitosan dressing in overall management of wounds?