Secondary closure of open sternal wound using mechanical creep and negative pressure wound therapy in an outpatient setting – a case report

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Summary

This case report demonstrates the secondary closure of an open sternal wound using mechanical creep and negative pressure wound therapy (NPWT) in an outpatient setting, focusing on the decrease of wound healing time and cost of treatment. An understanding of the relationship between the prevention and treatment of surgical site infections (SSIs) is discussed. Furthermore, the importance of a multidisciplinary team (MDT) approach involving a cardiothoracic surgeon, wound care nurse, and dietitian to achieving wound healing using mechanical creep, NPWT and good wound management is demonstrated. In this patient, the mechanical creep technique using TopClosure® and NPWT proved to be effective and led to a 60% decrease in wound size by week 4, and complete wound closure by week 9.

Keywords: secondary closure, negative pressure wound therapy (NPWT), mechanical creep, sternal wound

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Introduction

Surgical site infections (SSIs), including mediastinitis, are one of the most significant complications in cardiac surgical patients and are associated with poorer prognoses accounting for a mortality rate of 25%.[1] The occurrence of postoperative wound infection is increased by modifiable risks such as the nature and type of surgery, length of preoperative stay and patient-related factors.[1] Due to the characteristics of cardiac surgery, invasive surgery, length of surgery and high operative and peri-operative risks, SSI rates can range from 3.5–21%, leading to a prolonged hospital stay, increased medical costs and decreased quality of life.[1] In SSI prevention, it is important to implement procedures reducing risk factors during both preoperative and intraoperative phases, such as prophylactic antibiotics, surgical site preparation and maintenance of blood glucose levels.[2]

Sternal SSI treatment involves rehospitalisation, surgical intervention, antibiotic therapy and application of negative pressure wound therapy (NPWT) to either allow the wound to heal by secondary intention or prepare the wound bed for secondary wound closure.[2] NPWT combined with antibiotics is considered the gold standard in the treatment of both deep sternal wound infections and sternal wound dehiscence not resulting in sternal instability.[3] Although these wounds are large and can take weeks or months to heal, many will heal satisfactorily by secondary intention without the need for further reconstructive management.[3] This case report demonstrates the secondary closure of an open sternal wound using mechanical creep and NPWT in an outpatient setting, focusing on the decrease of wound healing time and cost of treatment.

Case report

A 68-year-old female underwent aortic valve replacement on 30 June 2022 at a private hospital in Pretoria, South Africa. The patient developed hospital-acquired pneumonia and remained hospitalised for another two weeks post-initial surgery. The patient was discharged from the hospital on 6 July 2022 with the ability to be self-sufficient at home. On 30 November 2022, the patient was taken to the casualty department after complaining of sharp shooting pain in her chest, and a red, warm and swollen sternal wound. Blood tests confirmed elevated C-reactive protein (CRP), indicating possible infection. The patient was admitted to the hospital on 1 December 2022 and underwent a surgical procedure for incisional drainage of sternal abscess with the implementation of NPWT. During surgical debridement in the theatre, it was noted that the K-wires used to close the sternum during aorta bypass was draining puss. K-wires were removed in the theatre and the sternum was left open to allow for wound drainage and wound bed preparation using NPWT. The wound was treated with continuous NPWT using antimicrobial wound contact layers and foam dressings for three days to decrease the bacterial burden and prepare the wound bed for secondary wound closure. The patient underwent secondary wound closure of an open sternal wound on 5 December 2022.

On 16 January 2023, five weeks post-delayed closure of the wound, the patient presented at the casualty department with chest pain and was found to have a swollen, red and painful sternal wound draining purulent exudate. The patient was sent for computerised tomography (CT) chest pre- and post-contrast, confirming that a residual thick-walled fluid collection was extending from the superior aspect of the retrosternal region to surround the ascending aorta as well as extending into the aortic annulus region and lying in relation to the superior

vena cava and extending to the right aspect of the pericardium. This demonstrated an increase in size when compared to the previous radiograph (8 September 2022) and most likely represented a chronic mediastinal abscess. Furthermore, blood tests indicated increased CRP, procalcitonin (PCT), and full blood count (FBC) detected neutrophil leucocytosis commonly caused by infection and soft tissue damage. On 17 January 2023, the patient was admitted for deep sternal infection, and treatment started with antibiotics and prepared for surgical debridement. The patient underwent surgical drainage of abscess and sternotomy, with the implementation of NPWT. Due to the patient's history, the wound was left to heal by secondary intention with the aid of traditional NPWT. Although it is believed that the use of NPWT is contraindicated in the use of infected wounds, there is growing evidence suggesting the benefit of NPWT as an adjunct therapy in the treatment of infected and complex wounds, as it promotes the formation of viable and healable tissue in the wound bed, reducing the need for complex surgical interventions.[4,5] Once the CRP levels have reached below 30, and the patient had no systemic reaction or complaints, the patient was discharged from the hospital on 20 January 2023 and attended the wound clinic on an outpatient basis twice a week, as the use of NPWT provided a fast and effective way to promoting wound closure while increasing the quality of life.

The patient was treated for two weeks on NPWT with a silver non-adhesive wound contact layer, and two dressings a week to prepare the wound bed for application of TopClosure® device aiming to help with mechanical creep and decreasing the wound size. A wound swab was done on 23 January 2023 in preparation for the implementation of TopClosure®, which confirmed that there was no bacterial growth. Figure 1 indicates the weekly progress of the wound after two weeks of NPWT.

Wound swab results indicated no growth over seven days. The wound bed was well granulated and prepared for the implementation of the TopClosure® device with NPWT. Figure 2 illustrates the steps taken to apply the TopClosure®.

NPWT was placed over the top close device to promote granulation tissue formation, decrease wound oedema and aid with decreased lateral tension on the wound bed. Figure 3 illustrates the wound progression during treatment.

Discussion

The treatment of deep sternal wound infections and SSIs is well argued, with little agreement in the literature, yet there is a consensus that wound debridement remains a necessity.[6] After sternal wound debridement, the wound will either be primarily closed with suture or

Implementation: 18 January 2023	Week 1: 23 January 2023	Week 2: 30 January 2023
		
L: 19 cm; W: 6.5 cm; D: 5 cm – 40% exposed bone	L: 19 cm; W: 6 cm; D: 5 cm – 20% exposed bone	L: 19 cm; W: 5.5 cm; D: 3.5 cm – no exposed bone

Figure 1: Weekly progress of the wound after two weeks of NPWT

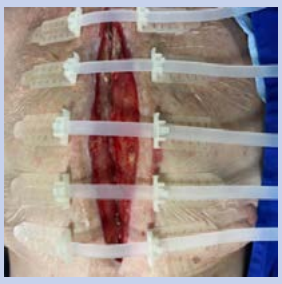
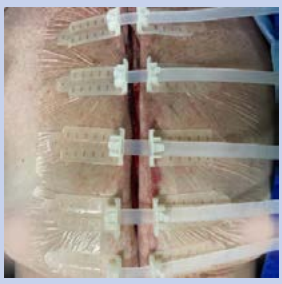
			
Clean wound and peri-wound area with preoperative skin preparation solution. Place TopClosure® base plates 2 cm away from the wound edge. Base plates must be adjacent to each other and secured to the skin using drape dressing or skin clips if available in an outpatient setting.	Insert TopClosure® cable through both base plates. Start pulling cables tighter to approximate wound edges. Start at the centre of the wound and move out towards the edges. Tighten the cable until wound edges have approximated or reached wound closure. Cut off excess cable and round all sharp edges.	A 60% decrease in wound size was achieved with the initial implementation of TopClosure®.	Apply NPWT dressing over the wound and TopClosure® device to ensure no sharp edges puncture the NPWT dressing by cutting the edges round or securing them with silicone paste.

Figure 2: Steps taken to apply the TopClosure® device – week 2, 30 January 2023

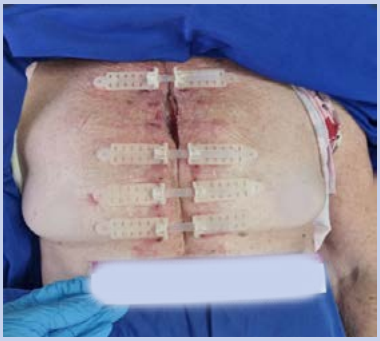
Week 3: First dressing change 2 February 2023	Week 4: Discontinued NPWT 9 February 2023	Week 9: Completed wound closure 20 March 2023
		
Wound drainage and pain had decreased. Sixty per cent of the wound edge had approximated and adhered with stable granulation. One TopClosure® device was lost due to poor skin adherence; this may be indicative that the device be secured to the skin using skin clips or stronger adhesive.	Top close devices were removed, and NPWT was discontinued as the wound had granulated; conventional care was applied using antimicrobial dressings (Cutimed® Sorbact® [DACC, BSN Medical, Germany]) once a week.	Complete wound closure with stable granulation tissue and epithelial advancement achieved.

Figure 3: Progression of the wound – week 3 to 9

left open for several days for observation and then closed by delayed primary closure, allowing for alignment and stabilising of the two sternal halves.[6] However, in the case of recurring sternal SSIs, the wound is left to granulate and heal by secondary intention, a long process that may take up to eight weeks or longer, depending on the size and location of the wound.[6,7] Repeated SSIs in sternal wounds are not uncommon and present with unique challenges such as rapidly progressing infection and osteomyelitis.[8] This is seen more frequently in other treatment methods, which use conventional dressings instead of NPWT.[8] However, even with the use of NPWT, the granulation tissue still needs to advance and progress through the stages of-healing by secondary intention.[8]

Mechanical creep using TopClosure®, a non-invasive innovative technology for the management of complex wounds, allows skin stretching and secure wound closure to occur on an outpatient basis.[9] The TopClosure® system is easily applied with varying anchoring distances over the wound bed. The larger surface of contact with the skin, provided by the broad and long base plate, reduces lateral tension applied to the wound, whilst stretching the peri-wound skin, allows for mechanical keeping.[9] Reducing the probability of dehiscence and promoting wound closure.[9] The NPWT was applied as a secondary dressing to promote angiogenesis and the formation of viable granulation tissue and decrease peri-wound oedema.[10,11] The combination of these two treatment methods has shown, in this case, to expedite wound healing.

NPWT was discontinued one week after application of the TopClosure®, and a moist wound environment was maintained using antimicrobial dressings (Cutimed® Sorbact® [DACC, BSN Medical, Germany]) once a week to decrease over granulation and promote epithelial advancement until complete wound closure was achieved on week 9. The total product cost of NPWT (five dressing cycles) and conventional wound care over six weeks (excluding hospital, theatre and Topclosure® costs) was valued at R18 8471.57, which was approved and fully covered by the medical funder.

Conclusion

This case report demonstrates that the Topclosure® device can be successfully used as an adjunct to NPWT for the treatment of open sternal wounds. The treatment pathway and clinical results showed may be a treatment consideration for patients treated in the outpatient care setting.

Conflict of interest

The author declares no conflict of interest.

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Ethical approval

Informed consent was obtained.

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