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MANAGEMENT OF A RARE CASE OF PEDIATRIC DEEP STERNAL WOUND INFECTION WITH VACUUM-ASSISTED CLOSURE (VAC)

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ABSTRACT

Introduction: Deep sternal wound infection (DSWI) or mediastinitis is a severe and life-threatening infection with high morbidity and mortality rates. Vacuum-assisted closure (VAC) provides good results and is very useful in wound closure. VAC therapy is a safe and affordable method for managing complex sternal and thoracic injuries. The use of VAC has been shown to increase parasternal blood flow by dilating arterioles, reducing bacterial load, and accelerating granulation tissue formation. It also helps with facilitating wound edge closure.
Case Illustration: A 6-month-old baby presented with an ulcer 2 cm deep in the thorax region. The wound had an exposed bone surrounded by slough and hyperemic edges. Bone destruction was seen to have reached the costochondral joint with a gross visible appearance of the pleura. Management of this patient included debridement, sternotomy, internal fixation of the sternum using the Robiscek technique, and application of the Water Shield Drainage (WSD) and VAC.
Discussion: The tobacco-sack technique was used to close the open wound. The Robiscek technique was used in this patient because of the bone destruction to the costochondral joints causing the sternum to become unstable. The VAC dressing was then connected to a suction with an intermittent negative pressure of 75mmHg. After a significant decrease in the wound surface area, a local rotational flap was used to close the wound.
Conclusion: The use of modified VAC for deep sternal wound infection (DSWI) is effective, simple, and affordable with minimal complications.

Highlights:

1. This case series demonstrates that the combination of micro and nano fat shows promising results for overcoming facial contour deformity.
2. Growth factors and stem cells in nano fat complemented the micro fat properties, thus increasing the survivability rate.

INTRODUCTION

Deep sternal wound infection (DSWI) or mediastinitis is a life-threatening inflammation of the mediastinal structures with an incidence of 0.5-6%. This infection results in increased mortality, morbidity, and decreased life expectancy, so a good

diagnosis and treatment algorithm is needed[1].

In mediastinitis cases, sternal debridement, mediastinal suctioning, and rewiring are the usual approaches, followed by wound closure using an autologous flap (omental or muscular). The application of plate fixation was also proposed, but the results are unsatisfactory. So, the use of negative pressure or vacuum therapy is recommended[2]. Vacuum-assisted closure (VAC) has been commonly accepted because it is effective in accelerating wound healing. Currently, the application and indication of VAC use in newborns and children have developed rapidly. However, several factors, such as cost and limited resources in developing countries, remain a problem[3]. Therefore, here we present the case of a child with DSWI and the procedure using a modified VAC.

CASE ILLUSTRATION

A 6-month-old baby presented with a lesion in the thoracic region that developed two weeks prior to admission. The patient initially had a fever, soon followed by the formation of an abscess with a diameter of 2 cm with yellow and then red fluid. Two weeks after, the abscess ruptured and formed an ulcer (Figure 1). The patient was compos mentis on admission with a length and weight of 78 cm and 8.7 kg, respectively. Vital signs were normal. Localized status in the thoracic area appeared to be an ulcerated wound with a depth of 2 cm, the edges hyperemic with bone exposure surrounded by slough with a visible appearance of the pleura. The generalized status of the abdomen and extremities did not reveal any abnormalities.

X-Ray imaging of the chest showed a lucent lesion in the right hemithorax region at the level of the medial aspect of costae III-V, suggestive of an abscess (Figure 2).

Figure 1. Deep sternal wound infection

Figure 2. Plain radiograph of the thorax shows a luscent lesion in the right

Supporting Multi-slice Computed Tomography (MSCT) with contrast revealed a subcutis defect on the thoracic wall at the level of the sternum with pneumatization in the subcutis to the subpleural parietal, right pleural effusion, localized bilateral effusion, accompanied by a collapse of the posterior basal segment of the right inferior lobe of the right lung (Figure 3).

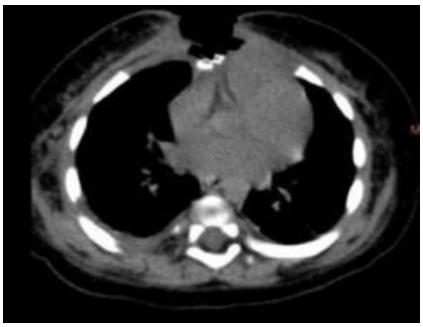

Figure 3. MSCT of the thorax with contrast showing a subcutis defect on the chest wall at the level of the body of the sternum

Bacterial cultures were performed on several specimens in this patient. *Staphylococcus haemolyticus* was found in the pre-debridement blood, *Salmonella sp.* was found on the base and wound tissue, *Burkholderia cepacia* was found in the post- debridement blood Meanwhile, further examination of tissue histopathology and pus cytology revealed chronic suppurative inflammation. Sputum Acid Fast Bacilli (AFB) examination showed negative results.

Debridement with sternotomy was performed at Dr. Sardjito Central General Hospital, Yogyakarta, Indonesia. Management of this patient required a multidisciplinary approach: internal fixation of the sternum with the Robiscek technique as well as application of Water Shield Drainage (WSD) by the Cardiovascular Thoracic Surgery team, and wound care using VAC by the Plastic Surgery team (Figures 4 and 5). The wound that had been treated with a dressing was connected to an infusion tube and a modified tube for fluid absorption, then covered with a transparent dressing to ensure an airtight condition. The infusion device was connected to suction with an intermittent negative pressure of 75 mmHg.

In this case, VAC was shown to be effective in reducing the wound area and also helped to decrease purulent discharge within 24 hours. The device was used for a total of 24 days, and evaluation and re-dressing were conducted every five days (Figure 6).

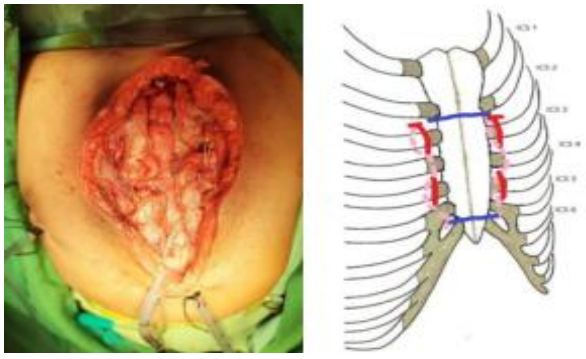

Figure 4. Sternal fixation with modified Robicsek technique using steel wire

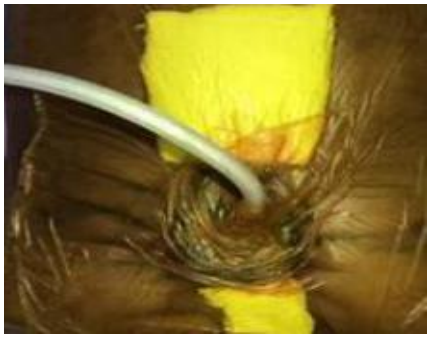

Figure 5. Application of VAC post-debridement

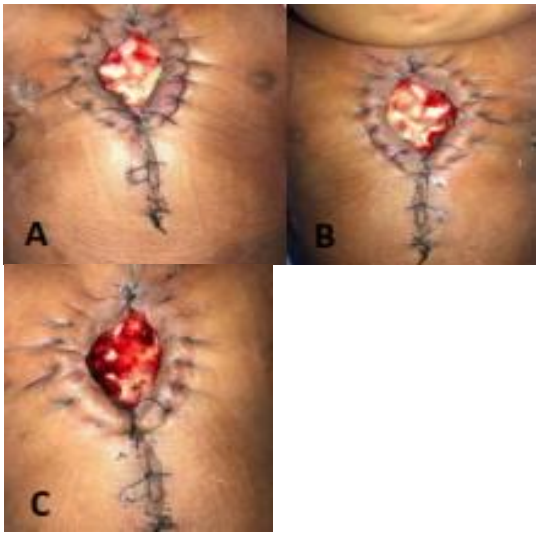

Figure 6. Evaluation of post-surgical debridement and reapplication of VAP.(A) Day 5: Granulation tissue begins to cover the sternum.(B) Day 10: The wound shows increased granulation.(C) Day 15: Granulation tissue covers the surface of the sternum.

Debridement of the necrotic tissue was performed around the wound. After a significant decrease of the wound surface area and increased visible granulation, a local rotational flap was used to close the wound (Figures 7 and 8).

Figure 7. Surgical debridement and defect closing with a rotational flap

Figure 8. First follow up post evaluation of decefct with rotational flap. (A) Day-14; (B) Day-44

DISCUSSION

Among Deep sternal wound infection (DSWI), also known as mediastinitis, is inflammation of the mediastinal structures and is life-threatening. Chest wall abscess is a rare condition that occurs spontaneously (primary infection) as a result of the hematogenous spread of pathogenic bacteria and fungi from a distant site of infection or secondary infection in open trauma or chest wall surgery. The patient's mortality rate is twice that of the usual case of infection. Reports state that these cases have a 10-47% chance of mortality. DSWI, although very serious, does not occur often[4].

It is important to differentiate DSWI from superficial sternal wound infection (SSWI). SSWI involves only the skin, subcutaneous tissue, and the pectoralis fascia[4]. The diagnosis can be made clinically by the presence of erythema, drainage, fever, and sternal instability. However, the symptoms are often atypical, with low-grade fever as the only clinical manifestation[5]. According to the Centers for Disease Control and Prevention (CDC), DSWI requires the presence of one of the following criteria: (1) organisms isolated from tissue culture or mediastinal fluid; (2) evidence of mediastinitis during surgery; or (3) presence of chest pain, sternal instability, or fever (>38.8C), and purulent drainage from the mediastinum, isolation of organisms present in blood cultures, or culture of mediastinal areas[1]. All three of the above criteria were seen in this patient, so a much more aggressive treatment regimen, consisting of early surgical debridement and long-term intravenous antibiotics, was required[6].

Therapy should be initiated as soon as the microbiological analysis is available. Blood, urine, and sputum cultures should also be performed[7]. In our patient, a urine culture was not performed because of the difficulty of sampling in children. For sputum samples, AFB was conducted and showed negative results. Culture examination revealed the presence of *Staphylococcus* bacteria, agreeing with studies that stated that these pathogens were identified mostly in cases of superficial and deep wounds that experienced complications[8].

Chest X-ray findings included mediastinal widening, pleural involvement, air-bubble formation within the mediastinum, and soft tissue mass or air-fluid level[9].However, these findings are non-specific and difficult to use in identifying the severity of the disease. Therefore, Computed Tomography (CT) is the best method for diagnosing DSWI. A CT scan also can be used to evaluate the lesion and the extent of the wound. Management of DSWI involves many procedures. Administration of antibiotics and several surgical techniques have been applied, but

have yielded unsatisfactory results[11,12]. In our case, there was a destruction of the sternum that extended to the costochondral joint, causing an unstable sternum. Therefore, the Robiscek fixation was performed. In the past few decades, various techniques and materials have been described and used for sternal reduction. In 1977, Robicsek et al. described an alternative method with bilateral and longitudinal running wires to stabilize the fractured and fragile or unstable sternum[13]. Some modifications of the Robicsek technique are still the gold standard in high-risk patients[14,15].

The Robiscek technique is often used to strengthen the sternum during primary sternal closure, where the sternotomy crosses the medial line and results in a thin and weak sternum on one side, or where the bone fracture has occurred and is also used as the first line of sternal reconstruction after primary closure dehiscence[15,16]. In patients with an increased risk of sternal instability and wound infection following cardiac surgery[17], sternal strengthening using the Robicsec technique is performed before primary sternal closure to not reduce the dehiscence rate[16,18].

Studies conducted in the last decade by Morykwas et al. suggested that the use of negative pressure therapy or VAC in highly infectious wounds, especially in the sternum, is able to give excellent results [13]. This action is the initial process before the patient is referred to a plastic surgeon. In addition, VAC therapy may be the only treatment option for patients who are too critical to withstand the stress of surgical debridement and reconstructive surgery[4,14].

Tang et al. treated 15 patients with sternotomy infection using VAC and succeeded, with only two mortality from complications of sepsis[15]. In our case, the use of negative pressure of 125 mmHg as induction therapy was conducted continuously for 48 hours and continued intermittently at the lowest threshold level of 75 mmHg[10,15]. The clinical response was found to be good and satisfactory. They are also used to splint the ribs, reduce paradoxical motion, and significantly improve the respiratory mechanism[16]. Costa was bandaged when clinical and evidence of infection resolved.

Vacuum-assisted closure (VAC) is an alternate way of wound management that employs negative pressure to prepare the site for spontaneous healing or for treatment with less invasive reconstructive alternatives. The administration of VAC involves complete debridement, sufficient hemostasis, and the placement of sterile foam dressing. A windowed tube is implanted in the foam and sealed with adhesive tape to create an airtight container. The fenestrate tube is coupled to a vacuum pump with a container for fluid collection. The device provides constant or intermittent suction between 50 and 125 mmHg. On the third day, the VAC dressings were replaced. Negative pressure treatment stabilizes the wound environment, decreases edema and bacterial load, enhances tissue perfusion, and promotes granulation tissue and angiogenesis. This increases the likelihood of primary wound closure and decreases the need for plastic operations. In terms of wound volume, depth, treatment time, and cost, VAC therapy appears to be simpler and more successful than standard bandages for the care of severe wounds. VAC therapy is a safe and affordable method for the management of complex sternal and thoracic injuries. VAC therapy has complementary functions and various indications, including pressure sores, stasis ulcers, chronic wounds such as diabetic foot ulcers, post-traumatic and postoperative wounds, infected wounds such as

wounds, infected wounds such as necrotizing fasciitis or sternal wounds, soft tissue injuries, open bone injuries, open abdominal wounds, and for skin grafts[7,10,17]. The use of VAC has been shown to increase parasternal blood flow by dilating arterioles and reducing bacterial load, thereby increasing granulation tissue formation[1]. At the same time, the VAC helps facilitate closing the wound edges, thereby stabilizing the thorax[17]. VAC therapy has been shown to have a positive effect on respiratory function and hemodynamics and has been used in the management of open thoracic injuries[6]. VAC therapy not only aids definitive wound closure, but also acts as a bridge for reconstruction so that cardiac surgeons can more easily place VACs on patients1. VAC therapy promotes faster wound healing, a shorter duration of hospital stay, and reduced mortality in the long term[17].

The study conducted by Gdalevitch et al. demonstrated that in patients with negative blood cultures, a wound depth of <4 cm, and low bone exposure and sternal instability, the use of VAC alone was likely to be successful[18]. The duration of VAC usage is still debatable. Management of complex wounds in infants is more difficult than in children because of the risk of significant extracellular fluid loss[3]. Several studies suggest an application of a thin Duoderm dressing between the skin and the plastic wrap to protect the skin surrounding the defect from maceration or mechanical injury when removing the plastic drape[3,5,7]. Flap reconstruction is considered standard therapy for DSWI. The concept of debridement and reconstruction involves the use of flaps to reduce dead space in sternal defects and provide mass (muscle or omental mass) to initiate wound healing. Lee et al. introduced the omentum flap in 1976[19], and later a more complex myocuaneous flap was developed by Jurkiewicz, namely the pectoralis major, rectus abdominis, and latissimus dorsi flaps[20]. In the patient of this study, VAC was placed first for 24 days. After the VAC placement, the wound appeared to be smaller with more visible granulation tissue. This was followed by the closure of the defect with a rotational flap. The flap was treated and evaluated postoperatively, and the wound healed very well.

CONCLUSION

The use of modified VAC in the management of deep sternal wound infection (DSWI) is effective, simple, affordable, and has minimal complications. Cases of DSWI require a multidisciplinary team. In this case, we utilized a modified VAC dressing to propel wound healing before closure with a rotational flap.

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CONFLICT OF INTEREST

There was no conflict of interest in this case research.

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AUTHOR CONTRIBUTION

All authors contributed to writing this case report.

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