Vacuum-assisted therapy with a handcrafted system for the treatment of wound infection after median sternotomy

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Abstract

The VAC (vacuum-assisted closure) system is a non-invasive therapy based on the application of negative pressure by controlled suction to the wound surface. This method has been proved to be effective on the promotion of granulation tissue proliferation. The aim of the study was to evaluate the effectiveness of the vacuum-assisted therapy with a handcrafted system, because the commercialized one was not available in our institution. Since July 2004, seven patients with sternal wound infection after median sternotomy were treated with vacuum-assisted therapy. All patients underwent surgical debridement under aseptic conditions. Thereafter, the patients received vacuum-assisted therapy with a handcrafted system. Complete healing with a tension-free wound direct closure was achieved in all patients, without morbidity. Removal of the system was done after a median of 15 days after surgery. All patients received intravenous antibiotics during the treatment. The cultures became negative after a median of 7 days.

Keywords: Mediastinal infection; Wound infection; Wound healing

1. Introduction

Deep sternal wound infection is a rare complication after median sternotomy. The reported incidence ranges from 1% to 5% [1,2]. Nevertheless, despite advances in antibiotic and wound-healing strategies, involving surgical debridement, drainage, irrigation and reconstruction using pectoral muscle flap [3], mortality remained constant at a rate until 30% [4–6].

In recent years, a novel technique using vacuum-assisted closure (VAC) has been increasingly used for the treatment of sternal infections [7,8]. The negative pressure leads to arteriolar dilatation and decreases fluid excess, the microcirculation is improved with granulation tissue proliferation and bacterial colonization is reduced. So, morbidity and mortality seem to be lower [9], together with a significant reduction of in-hospital stay and in the overall costs per patient compared to conventional treatments [10].

We report here about our experience with a handcrafted system, because the commercialized one was not accessible in our institution (KCI Inc., San Antonio, TX), due to a cost issue.

2. Patients and methods

Since July 2004, when we started the cardiac surgery in our institution, we decided to incorporate the vacuum-assisted therapy to treat all patients with sternal infections, because of good results in previous reports [7,8,10]. Seven patients (3 men [43%], 4 women [57%]) with a median age of 67 years (range 55–81 years) with sternal wound infection after cardiac surgery (coronary artery bypass grafting [CABG] = 4 [57%], CABG + aortic valve replacement = 2 [29%] and aortic valve replacement = 1 [14%], were managed with the vacuum-assisted therapy. The left internal thoracic artery was used as a graft in all patients who underwent CABG. Risk factors identified were diabetes in three patients (44%) and obesity in four patients (57%). No patients required immunosuppressive agents.

The deep sternal wound infection was suspected clinically, based on purulent or serous exudation from the sternal wound with further signs of infection, such as sternal pain, sternal instability, wound dehiscence and fever, after other causes of infectious origin were excluded. Sternal infection was confirmed by bacterium isolated from the culture of mediastinal tissue or fluid.

Clinical manifestation of sternal infection was presented after an operation with a median of 21 days (range 10–39 days). Five patients (71%) had been discharged and readmitted after they developed fever and purulent exudates from their sternal wounds.

According to the definitions of sternal wound complications by El Oakley and associates [11], we identified six patients with type IIA (86%) and another one with type IIB (14%). Based on the time of presentation, risk factors and
failed therapeutic trial, all patients presented mediastinitis type IIA.

Bacterial cultures isolated *Staphylococcus aureus* in three patients (43%), *Staphylococcus epidermidis* in two patients (28%), *Escherichia coli* in one patient (14%) and *Haemophilus influenzae* in another one (14%). Furthermore, *S. aureus* were isolated in a blood culture in one patient.

The antibiotic therapy usually commenced with vancomycin and gentamicin intravenously and continued until the results of the tissue cultures became available. Thereafter, the antibiotic therapy was adjusted according to bacterial sensitivity.

### 2.1. The handcrafted system

After sternal infection was diagnosed, the patient was taken to the operating room and the wound was explored under aseptic conditions and general anesthesia. After reopening the wound, aggressive debridement with removal of all necrotic tissue and sutures, and irrigation with hypertonic saline solution was done. In a patient with type IIB, sternal wires were removed with debridement of the sternal bone with a sharp spoon. In all cases, sternectomy was avoided.

Thereafter, the patients received vacuum-assisted therapy with a handcrafted system (Fig. 1). The system included: a Blake® 19F drainage tube (Ethicon, Inc.), a sterile bath sponge (Actibel-3M®) and a transparent waterproof adhesive drape OpSite® (Smith + Nephew).

The drainage went through the sponge. The spare sponge was cut wider than the sternal diastase, to allow volume reduction when the vacuum was applied. Then, the sponge was inserted into the wound. Finally, the open wound was sealed with a transparent adhesive drape, overlapping the wound margins. The drainage tube was connected to a purpose-built vacuum source, which delivers continuous negative pressure of 100–125 mmHg. A canister collects exudates from the wound.

All patients were extubated immediately after vacuum-assisted therapy application in the operating room, and left the intensive care unit after 2 to 3 h.

The patients were able to move around on the ward with the vacuum-assisted therapy system in place and received physiotherapy. The suction was well maintained and the patients did not need any special nursing care.

The vacuum-assisted dressing was renewed every 72 h, or earlier, depending on the evolution, under aseptic conditions without general anesthesia, and tissue cultures were obtained from different sites of the wound.

Minor air leakage was observed occasionally, requiring complementary draping.

### 3. Results

Complete healing was achieved in all patients, with stable sternotomy and without recurrent sternal fistulae. During follow-up there was no procedure-related mortality and no postmediastinitis mortality. None of the patients needed conversion to conventional dressing due to a system failure.

There was no morbidity or adverse effects related to the system, probably because most of the cases were type IIA, except for a minor air leakage that was observed occasionally.

The tissue cultures became negative after a median of 7 days (range 2–21 days). Removal of the vacuum-assisted therapy system was done after a median of 15 days (range 8–47 days).

The guidelines for vacuum-assisted therapy removal were negative bacterial cultures, no fever, and macroscopic infection-free wound, and in the last patient, a decrease of plasma C-reactive protein levels [12].

Finally, subcutaneous tissue and skin were sutured with interrupted sutures, with a tension-free wound direct closure, without the use of pectoral muscle flaps [13]. In a patient with type IIB, sternal rewiring was not performed.

### 4. Discussion

In recent years, the VAC technique is a novel approach in wound-healing management. Several studies have reported promising results, although published series are not large.

Our experience is based on a handcrafted system that we have developed, similar to the VAC system (KCI Inc., San Antonio, TX), which is a safe and easy option when the commercialized system is not available in the institution. Vacuum-assisted therapy allows open drainage that continuously absorbs exudates with simultaneous stabilization of the chest and isolation of the wound. This therapy stimulates granulation tissue formation in combination with an increased blood flow in the adjacent tissue. In addition, we think that this kind of therapy is also applicable to other wounds.

All patients were extubated immediately, despite obesity (four patients) and chronic pulmonary disease (one patient).

Although we have not encountered any complications or morbidity, probably due to the small sample size and the type of mediastinitis, we have to point out the rare right ventricular rupture [14,15], during the use of the pressure suction. The rupture results from the overstretching of the right ventricle, which is adherent to the sternum and adjacent to the chest wall, during a sudden increase in
intrathoracic pressure (e.g., coughing or vomiting), as suggested in previous reports. Routine placement of paraffin gauze or a small towel over the surface of the right ventricle and between the two halves of the sternum before applying the suction dressing may reduce adhesions and prevent shearing forces between the sternal edges and the beating heart, and minimize trauma between dressing changes.

Obviously, there are limitations in this study: it was done with a small sample size, without any control group, and nonrandomized. Furthermore, we have not compared it to the commercial VAC system because it was not available. It would be helpful to do some comparison of costs between the two systems, designed to know if the handcrafted system could well be a more cost-effective option, even where the commercial VAC is available. Further studies are required to know if our handcrafted system is equivalent or superior to the commercialized one, although these results are in accordance with the previously published studies, and we think that the vacuum-assisted treatment principle is more important than the availability of the commercialized device.

5. Conclusion

The vacuum-assisted therapy system is a valuable and effective tool in the management of patients with wound infection after the most commonly used surgical incision in the field of cardiothoracic surgery, and can improve medical outcome in comparison to conventional therapy. Our handcrafted system, based on the negative pressure principle, is an innovative, safe and easy option when the commercialized one is not available, and can be used to achieve good results in the management of sternal wound infections.

References