Vacuum-assisted suction drainage versus conventional treatment in the management of poststernotomy osteomyelitis

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Abstract

Objective: The purpose of our study was to compare vacuum-assisted suction drainage (VASD) to conventional wound management, in the treatment of poststernotomy osteomyelitis (SOM).

Methods: We included a total of 42 patients that developed poststernotomy osteomyelitis and required open wound management, between 1998 and 2000, in this study. Twenty of these patients were treated by VASD and the other 22 by conventional wound management. The patients were well comparable with regards to age, presenting postoperative day, infecting organism and risk factors for osteomyelitis. This was a retrospective study.

Results: The patients treated by VASD had a significantly reduced treatment duration (mean 17.2 \( \pm \) 5.8 vs. 22.9 \( \pm \) 10.8 days, \( P = 0.009 \)) and total hospital stay (mean 27.2 \( \pm \) 6.5 vs. 33.0 \( \pm \) 11.0 days, \( P = 0.03 \)). Perioperative mortality was similar, with one early death in each group.

Conclusion: We conclude from our experience in the treatment of 42 patients with poststernotomy osteomyelitis that VASD shortened wound healing and hospital stay and thus proved to be an excellent alternative to conventional open management of these wounds. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Vacuum; Osteomyelitis; Sternotomy

1. Introduction

Despite many recent advances in the understanding of the physiological basics of wound healing, their treatment remains a difficult challenge. Sternotomy infections following cardiac surgery may involve superficial wounds, sternum osteomyelitis and mediastinitis. Especially poststernotomy osteomyelitis (SOM) remains a major cause of morbidity, resulting in prolonged hospital stay and often repeated surgical procedures. Frequently large tissue defects develop that require plastic surgery.

During the last decade vacuum-assisted suction drainage (VASD) has been established as an alternative method of wound treatment. It is based on applying subatmospheric pressure to the wound through a polyurethane foam dressing and has been shown to improve wound granulation and reduce bacterial counts. In addition wound edges are approximated, thus reducing wound sizes. In this study we report our experiences in the treatment of SOM with VASD in comparison to conventional wound management.

2. Methods

Between 1998 and 2000 a total of 42 patients required open wound treatment for SOM. In May 1999 VASD was introduced to our department. Until then all patients were treated conventionally. Thereafter, both treatment forms were used. Allocation to treatment groups was left to the surgeon’s discretion and occurred in a nonrandomized fashion.

Conventional treatment consisted of reexploration, removal of sternal wiring and debridement of all nonviable tissues. The wound was then washed with hydrogen peroxide and rinsed with saline solution. The extent of infection and debridement determined the subsequent treatment.

Patients with deep-seated wound infections with extensive involvement of the mediastinum and sternum osteomyelitis, that required resection of the whole sternum and had subsequent pectoralis major advancement flap procedures, were treated by open drainage in the conventional group (\( n = 3 \)) and by vacuum-assisted suction drainage in the VASD group (\( n = 4 \)).

Patients that had confined sternum osteomyelitis with evidence of infection in the retrosternal space and extensive infection of the presternal tissues, necessitating wide debridement of the subcutaneous tissues but allowing for rewiring of the sternum, were treated by placement of two 16
Charriere catheters for irrigation and two 28 Charriere chest tubes for drainage of the mediastinum, sternal rewiring and conventional open treatment of the presternal tissues in the conventional group (n = 8). Irrigation with saline solution was continued until drainage was clear and chest tubes then removed. In group 2 these patients were treated by vacuum-assisted suction drainage (n = 12). Patients with infection confined to the sternal wound edges where debridement revealed underlying healthy bone and varying degrees of infection of presternal tissues were treated by rewiring of the sternum and conventional open treatment of the presternal tissues in the conventional groups (n = 11) and by vacuum-assisted suction drainage in the VASD group (n = 6).

All 20 patients in group 2 received VASD as a first-line treatment (Fig. 1). After reexploration, removal of sternal wires and debridement of all infected and nonviable tissues, the wounds were washed with hydrogen peroxide, rinsed with saline solution and the sternum rewired. Then polyurethane foam with an embedded noncollapsible evacuation tube was tailored to fit the size of the tissue defect. In deep wounds several foam layers were placed on top of each other. The whole area was then covered with a transparent adhesive drape. The foam was connected through the evacuation tube with a VAC vacuum pump (KCI International, San Antonio, TX). The suction generated a continuous vacuum in the polyurethane foam, producing a high contact zone in the wound–foam interface, and thus a vacuum seal was achieved. The VAC pump was set to generate a negative pressure of 125 mmHg. Secretions were drained into an exchangeable reservoir canister, connected to the VAC pump. Alternatively we used Redon drainage bottles instead of the VAC pump, to give patients more mobility. The vacuum caused the foam to reduce in volume, pulling the wound edges together and giving it stability. The foam dressing and evacuation tube were changed every 2–3 days, to prevent granulation tissue ingrowth into the foam. These procedures were carried out on the ward, as they are painless and do not require analgesia. Upon change of dressing the wounds were regularly inspected and debrided as necessary. After granulation tissue filled the defect and all microbiological cultures were negative, primary closure of the wound was performed.

Perioperatively patients in both groups routinely received antibiotic prophylaxis with a single dose of 1.5 g of Cefuroxime. Once SOM was diagnosed, broad-spectrum antibiotic treatment was initiated and modified according to culture results. Patients were discharged once their wounds were clean and if their clinical condition was satisfactory. Three patients in the VASD group were discharged before wound closure was complete and treated on an outpatient basis.

All clinical records were reviewed retrospectively. Data obtained included patient demographics, procedures, measured wound size, infecting organism, risk factors for SOM, hospital stay, treatment time and time of presentation. Variables from both groups were analysed with Fisher’s exact test. Statistical significance was accepted for P values of less than 0.05.

3. Results

3.1. Conventional group

There were 22 patients in the conventional group, aged 50–83 years (median 66 years). Gender distribution in this group was 19 males and three females. Seventeen patients had isolated coronary artery bypass grafting (CABG), two underwent CABG and aortic valve replacement (AVR), one had CABG and carotid endarterectomy, one had CABG and concomitant left ventricular aneurysm resection, and one had isolated AVR. In nine of these patients both internal mammary arteries were used as bypass conduits. All but two patients had selected risk factors for SOM. Nine patients were diabetic, six had chronic obstructive pulmonary disease (COPD) and eight were overweight (Table 1). All
but one patient had positive microbiology cultures from their sternal wound specimens including Staphylococcus aureus \( (n = 9) \), Staphylococcus epidermidis \( (n = 4) \), methicillin-resistant S. epidermidis (MRSE) \( (n = 4) \), methicillin-resistant S. aureus (MRSA) \( (n = 1) \), Escherichia coli \( (n = 1) \), Enterococcus \( (n = 1) \) and Pseudomonas \( (n = 1) \).

The presentation with SOM varied from postoperative day 7 to 21. The duration of treatment lasted from 10 to 31 days (mean 17.2 ± 5.8 days). The total hospital stay ranged from 17 to 41 days (mean 27.2 ± 6.5 days). Hospital mortality was 5\% in this group \( (n = 1) \).

When comparing both treatment groups we found that, perioperative mortality did not differ significantly, with one early death in each group. The duration of conventional treatment was significantly longer than treatment by VASD \( (P = 0.009) \). The total length of hospitalization was also significantly increased in the conventional group \( (P = 0.03) \). A summary of these results are shown in Table 2.

Our analysis of the formation of granulation tissue that ultimately lead to secondary wound healing showed an average of 3.2 cm\(^2\)/day (range 2.7–3.6) reduction in wound size in the conventional group and 4.63 cm\(^2\)/day (range 2.9–6.5) in the VASD group (Fig. 2).

### 4. Discussion

Poststernotomy osteomyelitis is a rare but potentially life threatening complication of cardiac surgery [1]. Its incidence of about 1\% has remained unchanged although profound efforts have been directed towards identifying and eliminating its causes and risk factors. For the affected patient the consequences are substantial as the morbidity is considerable and the associated mortality of 10–50\% high [2,3].

In our series of patients, the incidence of SOM was 0.9\%. This rate was constant over the last 3 years, although strict prophylactic measures were implicated. The overall SOM associated mortality in our group of patients was 4.7\%. These findings are comparable to those of other study groups [4,5].

In our institution, the conventional treatment of SOM usually consists of reexploration and assessment of the

![Speed of secondary wound healing](image)

**Fig. 2.** Effect of vacuum-assisted suction drainage (VASD) on time course of sternal wound healing compared to conventional open management.
extent of infection, followed by complete excision of all nonviable and infected tissues. Thereafter, depending on the extent of debridement, primary closure is attempted including the use of closed irrigation systems. These are often cumbersome in use and have numerous problems like absorption of irrigation solution, blockage, hazardous measurement and culture of exudate as well as no access for repeated debridement. Similar experiences with closed irrigation systems are described in the current literature [6,7].

In patients with deep-seated infection, extensive wound debridement and open drainage becomes necessary. In our experience, however, this bears a number of problems, in particular the disadvantage of chest instability necessitating mechanical ventilation and the heavy burden on nursing staff [8]. Alternatively muscle flap closure of the defect can be attempted, with its advantages of increasing wound vascularity and providing some stability to the chest [9]. However, implanting a muscle flap into a poorly vascularized and potentially infected surrounding in an acutely ill patient has a considerable rate of short-term failure and a number of long term functional deficits [10].

In 20 of our patients with SOM we employed vacuum-assisted suction drainage, applied via polyurethane foam. This technique was first used in the field of plastic surgery and combines the benefits of both closed and open wound treatment [11,12]. Vacuum sealing protects the wound against contamination and furthermore, excess interstitial and putrid wound secretions are continuously removed thereby preventing fluid retention [13]. The vacuum suction stabilizes the wound, avoids wound edge retraction and reduces pain. Patients can be mobilized early and even discharged and treated on an outpatient basis. Three of our patients were treated this way with excellent clinical and cosmetic results. However, compliance of the patient is a key factor in out-patient treatment, as the wound dressing is changed only every 2–3 days.

In our opinion, the foremost advantages of vacuum-assisted suction drainage over conventional therapy is the accelerated formation of granulation tissue, a marked improvement in wound vascularization and decreased bacterial colonization. The stimulation of tissue granulation makes secondary closure with myocutaneous flaps unnecessary, as even large defects are covered within a short period of time. Therefore, additional major and mutilating surgery can be avoided. In our group of patients, those that were treated by VASD had a significantly reduced duration of treatment and total hospital stay.

In conventional treatment, wound dressings have to be changed twice daily, whereas in VASD the polyurethane foam only needs changing every 2–3 days. It is therefore less discomfoting and time-consuming for patients and nursing staff.

We conclude from our experience in the treatment of 42 patients with poststernotomy osteomyelitis that vacuum-assisted suction drainage proved to be an excellent alternative to conventional open and closed management of these wounds. Plastic surgical procedures like myocutaneous muscle flap treatment can be avoided. The treatment and hospitalization times are significantly reduced and with appropriate compliance and equipment, VASD can be carried out on an outpatient basis, thereby reducing hospitalization costs and improving quality of life for patients.

Several other authors also have reported their experiences with VASD for the treatment of poststernotomy osteomyelitis [13–16] (Table 2). Tang et al. [16] state that the VASD method is applicable for both superficial and deep sternal wound infections. Its strength lies in the promotion of healing in difficult wounds with complex etiologies, which failed to respond to established treatments. Obdeijn et al. [14] point out that apart from being a valuable adjunct in the early management of poststernotomy osteomyelitis, a healed, stable sternotomy wound can be achieved with this technique without a second operation. Hersh et al. [17] used the VASD method as a bridge to sternal wound closure. They state that the method is a safe and effective therapeutic strategy for patients with impaired physiologic reserve and/or highly contaminated wounds. Also, its stabilizing characteristics allow for post-debridement extubation, reducing the need for prolonged paralysis and mechanical ventilation.

Disadvantages encountered using the VASD system are relatively few. Some patients reported pain when subatmospheric pressure was applied to their sternal wounds. In our experience this was easily relieved by applying the pressure slowly. However, overall the VASD foam dressing is perceived as more comfortable than saline wet gauze dressings. Excessive ingrowth of granulation tissue into the foam dressing can occur when not changed after 3 days. Thereafter, removal of dressing disrupts the newly formed granulation tissues. This can be avoided by ensuring that the patient has regular changes of dressings every 2–3 days.

4.1. Limitations of the study

Our study was retrospective, with the two groups operated upon in series by several surgeons. The sample size was small and therefore, significant differences in outcome have to be interpreted with care. It is possible that part of the reduced treatment and hospitalization times with VASD were due to a lesser severity of infection in this group. It would be necessary to balance the different patient and wound variables. Undoubtedly, a prospective, randomized trial would provide more definitive conclusions regarding superiority of a particular technique.

References


