Institutional report - Congenital

Vacuum assisted closure therapy for the treatment of sternal wound infections in neonates and small infants

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Abstract

Sternal wound infections occur with an incidence between 0.4 and 5% in the adult as well as the pediatric population. However, in contrast to the adults, established treatment options do not exist in the pediatric population. We evaluated our preliminary results with 3 neonates, respectively, small infants (mean age 20.3 ± 6 days) who underwent vacuum assisted closure (VAC) therapy for the treatment of sternal wound infections with the intention to enable secondary closure and preservation of the sternal bone. The mean VAC duration was 11.3 days, ranging from 10 to 12 days. After three dressing changes (every 48 to 72 h) the infection resolved and a secondary closure was feasible in all three patients. Isolated specimens were Candida albicans, Staphylococcus aureus and MRSA, respectively. These preliminary results show that VAC therapy is a promising alternative to the current treatment options available to neonates. Especially, the preservation of the sternal bone which enables normal thoracic cage stability and growth, is a clear advantage over the currently used muscle flaps.

1. Introduction

In pediatric cardiac surgery, access to the heart is usually obtained via median sternotomy. Despite the high numbers of procedures performed, reports about the incidence of sternal wound infection in the pediatric population are rare [1,2]. Even more, when focused on the therapy of such infections in a neonatal population, reports regarding the treatment of sternal wound infection are scarce [3–5].

The occurrence of sternal wound infection is described in the current literature with 0.4 to 5% [1,2].

Whereas established treatment modalities exist in the adult population, this has not been the case in the pediatric cohort. Neonates with congenital heart defects are representing a unique patient population with an immature immune system which has to deal with early and sometimes repeated surgical interventions.

The vacuum assisted closure therapy, introduced in 1997, rapidly emerged as a valid treatment option for post-sternotomy mediastinitis in the last 3 years [6–10].

However, so far there is no experience in pediatric cardiac surgery with the VAC system.

As we have recently gained a lot of encouraging experience with the VAC system in the adult cardiac surgery patients, we wanted to try this treatment option in the pediatric population [9,11,12].

Keywords: Sternal wound infection; Vacuum assisted closure; Small infant; Cardiac congenital surgery

2. Material and methods

Since March 2005 to September 2005 we treated 3 neonates, respectively, small infants with vacuum assisted closure for sternal wound infection.

There were 2 females and 1 male, mean age 20.3 ± 6 days (ranging from 14 to 26 days) at the time of VAC implant.

Patient 1 was born with an idiopathic dilated cardiomyopathy and underwent an arterial-venous ECMO implantation via the jugular vessels on his 10th day of birth before urgent heart transplantation after 10 days on ECMO support.

Patient 2 had a Di George syndrome associated with an interrupted aortic arch between the left carotid artery and the left subclavian artery, a perimembranous VSD and a PDA. One stage repair was performed on the 4th day of life with ECMO implant and open sternum. Subsequently, 1 revision for bleeding and ECMO explant were done before closure of the sternum.

Patient 3 was born with a trisomy 21, hypoplastic aortic arch and atrioventricular septal defect.

Correction of the hypoplastic aortic arch and placement of a pulmonary artery banding was performed on the 4th day of life. Twelve days later the pulmonary banding had to be tightened.

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Associated known risk factors for developing postoperative wound infections were present in our patients. In detail those were: immunosuppressive therapy after cardiac transplantation in patient 1 or immunodeficiency due to thymic aplasia in patient 2, preoperative or postoperative ECMO support, high doses of beta adrenergic drugs in all three patients, delayed sternal closure due to hemodynamic instability and myocardial edema in patient 1 and 3 and bleeding tendency and central ECMO placement in patient 2, and three operations in a three-week time interval in patient 3.

2.1. Therapy protocol

All procedures were done on the pediatric intensive care unit.

After reopening of the wound and removal of all suture material, bacteriological cultures were taken. Then surgical debridement for removal of necrotic tissue was performed. Thereafter a piece of the adhesive drape was cut to extend the wound edge to 2 cm and was placed onto the wound as a skin barrier. Thereafter the drape was cut to expose the wound. A piece of foam was cut and fitted into the sternal wound fixed with adhesive drape. Then, in contrast to adults, only a 1-cm in diameter hole was cut into the drape for the VAC pad. A VAC pad was thereafter placed onto the sternal wound (Figs. 1 and 2).

The VAC settings were adjusted to 50 mmHg continuous mode. Every 72 h, the dressing was changed under aseptic conditions on the ICU with adequate reaction and improvement of the wound as seen in the adult population (Fig. 3). After the first dressing change the VAC settings were changed to the intermittent mode of 3–5 min of vacuum, with the intention to enhance granulation tissue proliferation. Intubation is not necessary for the VAC change, as one patient was already extubated and tolerated the VAC changes with only a slight sedation.

When the wound was macroscopically free of infection and the cultures taken at every dressing change were negative, definitive therapy with secondary wound closure was employed.

Wound closure was done in the same fashion as at the time of cardiac surgery. Closure of the sternal bone was performed with five single sutures, 2-0 Dexon. Closure of the fascia and subcutaneous layer was sutured with 3-0 Vicryl in a continuous fashion and the skin was closed with 5-0 Maxon.

3. Results

A total of 36 operations with cardiopulmonary bypass on neonates (under 4 weeks of age) with complex cardiac defects have been performed since 2003 at our department.

The incidence of sternal wound infections in this population can be calculated with 8.3% \( (n = 3) \).

Infection began within a mean of 8.8 days (from 5 to 14 days) after closure of the sternum. In two patients, the sternum was left open after surgery and was subsequently closed after 2 and 4 days after surgery, respectively. In
risk factors of sternal wound infections in the pediatric population. As well as an increase in the cost of care resulting in an increased morbidity, prolonged ICU and hospital stay as well as an increase in the cost of care. surgery. Moreover, the associated risks of transporting a severely ill neonate could be excluded as the VAC implantation, the dressing changes and the secondary closure was performed at the pediatric ICU.

4. Discussion

Surgical site infections after cardiac surgery procedures result in an increased morbidity, prolonged ICU and hospital stay as well as an increase in the cost of care.

Several reports exist, which evaluate the incidence and risk factors of sternal wound infections in the pediatric population [1,2,10,11]. However, papers dealing with the optimum treatment of such infections are rare [3–5]. Due to the small number of neonates with sternal wound infections, no attempts have been made to develop alternative treatment methods, as those which have been already established in the adult population. However, as the neonate with a sternal infection represents a unique population which has to cope with an immature or even deficient immune system and early surgery, an effort should be made to interfere as little as possible with the existing structures.

patient 3, an MRSA was isolated in blood cultures after the second operation, which subsequently involved the sternal wound (Fig. 4).

VAC therapy lasted a mean of 11.3 days, ranging from 10 to 12 days with three dressing changes performed in all three patients.

Isolated specimens were Candida albicans in patient 1, Staphylococcus aureus in patient 2 and MRSA (Methicillin resistant Staphylococcus aureus) in patient 3. Patients 1 and 2 had an associated bacteremia, whereas patient 3 had an MRSA sepsis before the onset of mediastinitis.

The VAC was well tolerated by the children as no changes in heart rate, blood pressure or respiration sequence were observed which could have been an indicator for pain experienced by the neonate.

No blood loss occurred during debridement, VAC therapy and secondary closure, and none of the three patients required transfusions.

Another important aspect is the fact, that the neonates did not require further surgery. Moreover, the associated risks of transporting a severely ill neonate could be excluded as the VAC implantation, the dressing changes and the secondary closure was performed at the pediatric ICU.

Cananio et al. recently reported their experience with the VAC system for several wound infections in a pediatric population with encouraging results [14].

Compared with the traditional treatment modalities, the uniform negative pressure applied to the wound leads to arteriolar dilatation and increased microcirculation, thereby optimizing the wound environment. By continuous suction, fluid excess and tissue edema are decreased which reduces bacterial colonization. These positive effects on the wound promote granulation tissue proliferation and accelerated wound healing. Furthermore, through the airtight seal additional wound contamination is effectively prevented [6,7].

Preservation of the sternal bone is an aim which should be attempted particularly in the pediatric population.

Beside the fact that thoracic cage stability and growth is dependent on an intact sternum, no long-term follow up is available in children with muscle flap closure after sternal wound infection. In a study of Erez et al., 50% of the patients had residual thoracic cage instability which required further surgery [5].

As stated in the results section, the VAC treatment did not affect the hemodynamics of the neonates, particularly ventricular filling, and cardiac output was not impaired by application of a vacuum with 50 mmHg. On the other hand, we achieved a satisfactory reaction of the wound with resolution of infection and the development of granulation tissue with this setting. In patient 1, we changed the settings to an intermittent mode to optimize granulation tissue in growth.

It is particularly important to note, that as already proven in the adult population [9], ventilatory support is not necessary during VAC treatment, as sufficient thoracic cage stability is achieved. One out of the three infants could have been extubated during VAC therapy, the remaining two infants were still on ventilatory support for reasons not related to the VAC system.

Another advantage of the VAC therapy is based on the fact, that the secondary closure of the sternum after cessation of VAC therapy is only a small procedure which does not require deep sedation of the neonate nor does it result in significant blood loss, when compared to plastic reconstructive procedures.

Therefore, we can conclude that the reconstruction of sternal wounds with a pectoralis muscle flap is an established treatment option in adult cardiac surgery. Neverthe-
less, when performed in children or even neonates, one has to take into consideration the functional deficits which have important implications on the future profession or sports activity in the affected children.

Therefore, preserving the sternal bone to enable a secondary closure seems especially important in this population.

With the VAC therapy an option has become available to realize this goal.

References


