Vacuum-assisted closure device for the management of infected postpneumonectomy chest cavities

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Background: Infected postpneumonectomy chest cavities may be related to chronic postpneumonectomy empyema or arise in rare situations of necrotizing pneumonia with complete lung destruction where pneumonectomy and pleural debridement are required. We evaluated the safety and efficacy of an intrathoracic vacuum-assisted closure device (VAC) for the treatment of infected postpneumonectomy chest cavities.

Method: A retrospective single institution review of all patients with infected postpneumonectomy chest cavities treated by VAC between 2005 and 2013. Patients underwent surgical debridement of the thoracic cavity, muscle flap closure of the bronchial stump when a fistula was present, and repeated intrathoracic VAC dressings until granulation tissue covered the entire chest cavity. After this, the cavity was obliterated by a Clagett procedure and closed.

Results: Twenty-one patients (14 men and 7 women) underwent VAC treatment of their infected postpneumonectomy chest cavity. Twelve patients presented with a chronic postpneumonectomy empyema (10 of them with a bronchopleural fistula) and 9 patients with an empyema occurring in the context of necrotizing pneumonia treated by pneumonectomy. In-hospital mortality was 23%. The median duration of VAC therapy was 23 days (range, 4-61 days) and the median number of VAC changes per patient was 6 (range, 2-14 days). Infection control and successful chest cavity closure was achieved in all surviving patients. One adverse VAC treatment-related event was identified (5%).

Conclusions: The intrathoracic VAC application is a safe and efficient treatment of infected postpneumonectomy chest cavities and allows the preservation of chest wall integrity. (J Thorac Cardiovasc Surg 2015;149:745-50)

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Infected postpneumonectomy chest cavities may occur in the context of a chronic postpneumonectomy empyema or in rare situations of necrotizing pneumonia with complete lung destruction that require pneumonectomy. In both situations, chest cavity infection control is challenging. It is often achieved by the creation of a temporary thoracic window through which gauze packing is performed with repeated dressing changes until granulation tissue covers the chest cavity. To accelerate the healing process, various techniques have been reported. One technique consists of the application of povidone–iodine-soaked towels throughout the chest cavity with negative pressure through chest tubes. This technique was demonstrated to decrease the time necessary for intrathoracic infection control.[1,2] More recently, negative pressure wound therapy application using a vacuum-assisted closure (VAC) device was shown to facilitate the healing of acute or chronic infection and is currently validated for the management of wounds in various areas of the body, including the chest cavity.[3-10] This strategy has been shown to promote wound healing through different mechanisms, including accelerated granulation tissue formation, decreased wound bacterial load, removal of excessive interstitial fluid, improvement of tissue oxygenation, and wound volume reduction.[11]

We recently published a study where 27 consecutive patients with severe intrathoracic infections of various etiologies were managed by intrathoracic VAC therapy.[12] We found that VAC therapy was efficient to control intrathoracic infections and allowed us to preserve chest wall integrity.[12] Patient acceptance of VAC therapy was good with fewer dressing changes and an accelerated recovery. Other groups have applied the VAC device for the treatment of chronically infected chest cavities and spaces and have endorsed our findings.[13-17] However, the application of VAC devices for the treatment of infected postpneumonectomy chest cavities has been reported only occasionally and some concerns have been expressed

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Abbreviations and Acronyms
VAC = vacuum-assisted closure
BPF = bronchopleural fistula

regarding its safety for this specific indication.[17,18] Here we report a consecutive case series of 21 patients with infected postpneumonectomy chest cavities who were managed by VAC therapy.

MATERIALS AND METHODS

We retrospectively reviewed the medical records of all patients who were treated for infected postpneumonectomy chest cavities by intrathoracic VAC therapy between January 2005 and December 2013. The study was reviewed and approved by our institution's ethics committee and individual patient consent was waived.

For each patient, we recorded and analyzed the following parameters: age, gender, comorbidities, side and indication for pneumonectomy, the presence of neoadjuvant and adjuvant chemotherapy or radiochemotherapy, and the presence or absence of bronchopleural fistula (BPF). For each patient, overall postoperative morbidity and mortality were noted as well as the duration of VAC therapy, microbiologic analysis of the chest cavity, and time to definitive chest wall closure with hospital length of stay. The patients were grouped according to the underlying cause of VAC treatment: those with a chronic postpneumonectomy empyema, and those with an empyema in the context of a destroyed lung or necrotizing pneumonia requiring pneumonectomy.

For patients with chronic postpneumonectomy empyema, the surgical management before VAC application was adapted according to the presence or absence of a BPF. In presence of a BPF, a rethoracotomy was performed, followed by the debridement of the chest cavity. The bronchial stump and the carina were dissected and debrided. The bronchial stump was closed by circumferential suturing of an extrathoracic muscle flap (serratus anterior or pectoralis anterior muscle flap) into the debrided stump as previously described.[19,20] In the absence of BPF, debridement of the chest cavity and chest wall was performed before VAC application. In situations of empyema associated to destroyed lungs or necrotizing pneumonia requiring pneumonectomy, bronchial stump and mediastinal reinforcement were obtained by the transposition of extrathoracic muscle flaps followed by the application of a VAC device. In cases where postpneumonectomy empyema was related to a bronchoesophageal fistula that had contaminated a pneumonectomy cavity, the fistula was identified and a serratus anterior muscle was transposed in the chest cavity to close the tracheal defect and separate it from the esophagus. The VAC was then applied in the chest cavity to stabilize the muscle flap on the trachea.

Finally, in the cases where postpneumonectomy empyema occurred in association with necrotizing pneumonia (ie, postlobectomy patients who developed necrotizing pneumonia of their remaining lobe or whole lung necrotizing pneumonias), surgical management consisted of completion pneumonectomy or direct pneumonectomy followed by VAC application in the chest cavity. Because of the massive inflammatory reaction and major risk of developing fistulas, a latissimus dorsi or serratus anterior (in cases of previous thoracotomies) was transposed inside the thoracic cavity to cover the bronchial stump. In all cases, VAC dressing was directly applied in the thoracic cavity after surgery.

In all cases, VAC dressing (KCI Inc, San Antonio, Tex) was applied in the thoracic cavity after surgical debridement and packing of the cavity with sterile dry gauzes (Figure 1, *A*) to avoid direct contact of the VAC device with the mediastinum. Polyurethane foam of 20 × 15 cm was then applied within the chest cavity overlying the gauzes that usually filled the chest cavity and 1 suction tube was sutured onto this foam (Figure 1, *B*). These dry gauzes were applied on the mediastinum because they were less difficult to remove in comparison to the black VAC foam and allowed proper drainage of the pleural cavity. A second foam was then placed within the chest wall defect of a 6 to 8 cm open thoracic window (Figure 1, *C*). The skin of the thoracotomy incision was closed by interrupted sutures except around the thoracostomy site (Figure 1, *C*) where a third foam was placed and covered by adhesive tape with the application of a second suction tube (Figure 1, *D*). As the VAC was producing negative pressure, no chest tubes were inserted. Both suction tubes were connected together to the vacuum pump and negative pressure, ranging from −50 to −75 mm Hg, was applied. Patients were maintained under general anesthesia when the negative pressure was applied on the VAC foam: in particular, we measured central venous and systemic blood pressure changes to identify potential hemodynamic changes related to mediastinal compression or shift. These were corrected before patient extubation.

The subsequent VAC dressings were systematically performed under general anesthesia. The skin was partly reopened and the intrathoracic dressing was removed through the thoracostomy. At the end of each procedure, the skin was closed leaving only the small area of pleurostomy covered with a foam to avoid scarring and edge retraction. The first VAC dressing change was generally performed 48 postoperatively and then twice a week until the healing process covers the mediastinum and the chest cavity with granulation tissue. At that time point, pleural space was then obliterated with antibiotic solution and chest wall closed in several layers. Microbiologic analysis was performed at each VAC change by sending the deepest foam for analysis. All patients were initially treated with wide-spectrum antibiotics with adjustment of antimicrobial therapy according to the microbiologic analysis for the time of VAC therapy and antibiotics were stopped 2 weeks after chest wall closure.

Follow-up in surviving patients consisted of a minimum of 3 months per patient, which is the standard postoperative follow-up period in our department.

RESULTS

Twenty-one patients were managed with an intrathoracic VAC device for infected postpneumonectomy cavities between January 2005 and December 2013. There were 14 men and 7 women. The median age of patients was 66 years (range, 32-77 years). Patient characteristics, comorbidities, and anesthesia risk score (according to the American Society of Anesthesiologists) are summarized in Table 1. Right- and left-sided treatments were performed in 14 (66%) and 7 patients (34%), respectively.

Twelve patients presented with a chronic postpneumonectomy empyema and associated in 10 of them with a BPF. The indication for pneumonectomy was non–small cell lung cancer (n = 7), Masaoka IV thymic tumors (n = 2), adenoid cystic tumor (n = 1), and mesothelioma (n = 2). In 9 patients, pleural empyema preceded pneumonectomy, which was performed in the context of a necrotizing pneumonia with a destroyed lung following lobectomy for lung cancer (n = 7), lung transplantation (n = 1), and whole lung necrotizing pneumonia (n = 1). Five patients had undergone neoadjuvant chemotherapy for N2 disease, whereas 4 patients had extensive pleural resection in association to pneumonectomy (9 of 21 patients; 42%). Microbiologic analyses of the chest cavity before VAC therapy revealed a bacterial or fungal infection