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Mini-thoracostomy with vacuum-assisted closure: a minimally invasive alternative to open-window thoracostomy

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ABSTRACT

Thoracostomy is a common treatment option for patients with stage III pleural empyema who do not tolerate pulmonary decortication. However, thoracostomy is considered mutilating because it involves a thoracic stoma, the closure of which can take years or require further surgery. A new, minimally invasive technique that uses the vacuum-assisted closure has been proposed as an alternative to thoracostomy. This study aims to analyze the safety and effectiveness of mini-thoracostomy with vacuum-assisted closure in an initial sample of patients.

Keywords: Infection; Empyema, pleural; Negative-pressure wound therapy; Thoracostomy.

Pleural empyema is a source of major morbidity and mortality worldwide. Recent studies have demonstrated that the incidence of pleural empyema remains high even in developed countries.[1] The recommended treatment for stage III pleural empyema, which is characterized by trapped lung,[2] is pulmonary decortication,[3] a major surgical procedure that produces significant surgical trauma and considerable morbidity/mortality, principally in patients with chronic comorbidities or who are elderly.[4] A less invasive alternative for treating phase lll pleural empyema is thoracostomy as classically described by Eloesser.[5] Thoracostomy has the advantage of being a minor surgical procedure that is quite effective in resolving infection. However, the procedure is considered mutilating because it depends on the creation of a large stoma, usually involving a 12 cm × 12 cm area and resection of at least two ribs (three ribs in most cases). Stoma closure can take years or require further surgery. In addition, even with thoracostomy closure, the anatomy of the rib cage is profoundly altered.

Vacuum-assisted closure was first investigated by Morykwas et al. in 1997.[6] Their original work follows on from studies of negative pressure that suggested that it improved healing.[7] The first data showed that negative pressure increased blood flow and local hyperemia.[8]

Currently, vacuum-assisted closure is a widely accepted technique for treatment of various types of infected wounds.[9] A recent systematic review[10] concluded that quality of life is initially impacted, especially in the first week, probably because of the anxiety caused by the constant presence of the device; however, at the end of therapy, the results regarding quality of life are superior to those of the control group.

Among the intracavitary indications for vacuum-assisted closure are treatment of perforated diverticulitis, peritonitis, and abdominal sepsis, with studies demonstrating not only the safety of using the vacuum-assisted closure in contact with the viscera but also the efficacy of the technique.[11,12]

In the chest, the most well-established indication for vacuum-assisted closure is treatment of mediastinitis following cardiac surgery.[13] A review published in 2013[14] concluded that, for patients with mediastinitis following cardiac surgery, the vacuum-assisted closure is better tolerated by the patient because it precludes the need for daily dressing changes, resulting in granulation and healing more rapidly and in reduced length of hospital stay.

The use of the intrapleural device was first targeted at accelerating thoracostomy closure. A retrospective study published in 2009[15] compared 11 patients who underwent thoracostomy with vacuum-assisted closure for treatment of pleural empyema with 8 patients who underwent thoracostomy with standard care. All of the patients in the group submitted to vacuum-assisted closure responded well, and the thoracostomy closed

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spontaneously or was closed with a muscle flap. In contrast, in the control group, stoma closure occurred in only 2 patients over a one-year follow-up period. In addition, there were 4 deaths in the control group.

Another possible, intrathoracic application of the vacuum-assisted closure technique is as an adjuvant in the treatment of empyema following pneumonectomy. A study compiling data from 9 papers concluded that the use of vacuum in these cases can reduce morbidity and length of hospital stay.[16]

Recently, Hofmann et al.[17] described a minimally invasive technique using a vacuum-assisted closure device that can be used as an alternative to thoracostomy in patients with phase III pleural empyema. The advantage of the technique is that it does not require rib resection, making the procedure less harmful from an aesthetic and functional standpoint. In addition, time to thoracostomy closure, which can also be regarded as time to resolution of the condition, appears to be shorter with the use of this minimally invasive technique. The disadvantage is the possible need for dressing changes and the high cost of using vacuum-assisted closure.

The same group[15] described a larger sample, consisting of 15 patients with postoperative or recurrent pleural empyema of parapneumonic etiology who underwent intrapleural vacuum-assisted closure without thoracoscopy. Study entry criterion was a Karnofsky performance status ≤ 50%, reflecting the frailty of that group of patients; patients with a bronchopleural fistula were excluded. The device used was a model that creates vacuum and also provides an antibiotic solution. Of those 15 patients, 7 had postoperative empyema. Overall, the results were as follows: resolution of the condition, in 11 patients; death, in 1; recurrence, in 1; and need for conversion to thoracostomy, in 2. The authors concluded that, considering the severity of those patients, the use of intrapleural vacuum-assisted closure provides a good response, with low morbidity and no deformities due to thoracostomy.

Despite the good results reported by the aforementioned studies, there have been no studies comparing the technique advocated by Hofmann et al.[17] with conventional thoracostomy in terms of effectiveness, duration of treatment, and incidence of complications.

Our group is responsible for treating a large number of patients with pleural empyema at various levels of severity. We consider vacuum-assisted closure, which is clearly less invasive than thoracostomy, an important item that should be included in our therapeutic arsenal, as long as the former is shown to have similar safety and efficacy to the latter. This study aims to analyze the efficacy and safety of vacuum-assisted closure in an initial sample of 3 patients, as well as discussing details about the technique.

The technique we standardized consists of placing the patient, under general anesthesia, in the supine position contralateral to the affected hemithorax and making a 5- to 6-cm incision like a mini-thoracotomy in the area defined by CT as the one with the largest cavity. The intercostal muscles are sectioned, and the pleural cavity is breached. To facilitate cleaning, we use a (30-degree) 10-mm endoscope and we aspirate secretions and remove debris with forceps and a pump; however, we emphasize that no attempt is made at performing decortication, in order not to cause air leakage (a possible contraindication to the use of vacuum). The cavity is washed with saline, and the volume of saline infused is used in the measurement. Subsequently, the vacuum-assisted closure sponge is introduced into the cavity, with care being taken to protect the skin, as well as the subcutaneous cellular tissue and muscle. Externally, the vacuum-assisted closure dressing is sealed with adhesive film. Finally, the dressing is connected to the vacuum-assisted closure tubing. The suction level is set to −125 mmHg (Figure 1). Patients are concomitantly treated with standard, culture-guided antibiotic therapy. Dressing changes are performed within 4-7 days—in the cases reported here, all dressing changes were performed on postoperative day 4—and the technique consists of removing the sponge, washing the cavity, measuring its volume with saline, and replacing the sponge into the cavity as described above. The parameters we use for consideration of closure are wound site status, assessed during dressing changes, and clinical improvement. For closure, we remove the sponge, wash and obliterate the cavity with saline plus gentamicin (in a procedure similar to that described by Clagett),[3] and close the skin. We do not use the video system for the dressing change or for closure.

Below, we describe the three cases.

Case 1: a 20-year-old male patient presented with a diagnosis of empyema secondary to retained pneumothorax. The patient underwent mini-thoracostomy with vacuum-assisted closure, a dressing change was performed on postoperative day 4, and the mini-thoracostomy was closed on postoperative day 7. There was a reduction in the volume of the residual cavity, from 200 mL to 30 mL. Hospital discharge occurred on postoperative day 8. The patient was asymptomatic at the outpatient follow-up visit six months later.

Case 2: a 44-year-old male patient presented with a diagnosis of parapneumonic empyema and no improvement of his condition following closed chest tube drainage. The patient underwent mini-thoracostomy with vacuum-assisted closure. A dressing change was performed on postoperative day 4, and the mini-thoracostomy was closed on postoperative day 7; there was a reduction in the residual cavity from 500 mL to 100 mL. The patient was discharged without symptoms on postoperative day 8 and had no complaints at the follow-up visit three months later.

Case 3: a 66-year-old male patient presented with a diagnosis of parapneumonic empyema. The patient underwent mini-thoracostomy with vacuum-assisted closure. A dressing change was performed on postoperative day 4, and the mini-thoracostomy was

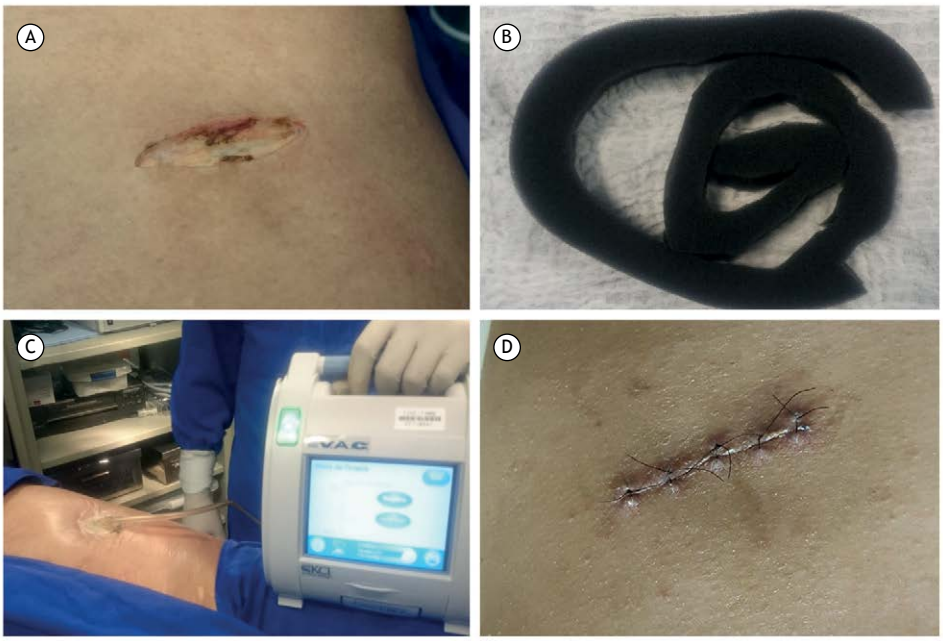

Figure 1. Photographs related to the technique. In A, incision; in B, sponge cut to fit the pleural cavity; in C, system connected to the patient and set to a pressure level of −125 mmHg; and, in D, final appearance after 15 days of closure.

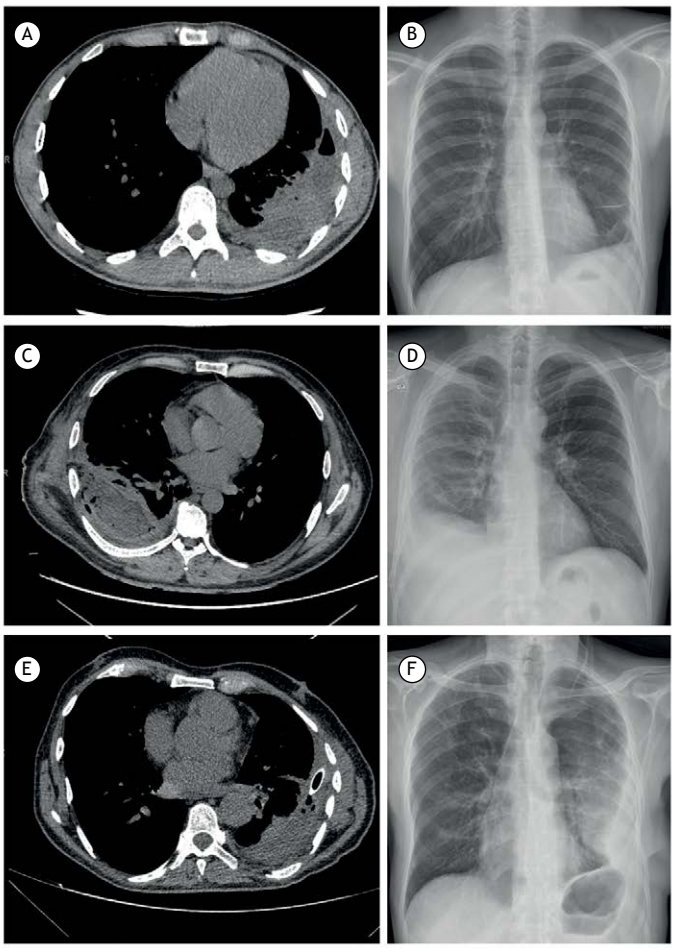

Figure 2. Preoperative chest CT scans and postoperative chest X-rays of cases 1 (in A and B), 2 (in C and D), and 3 (in E and F), respectively.

closed on postoperative day 7; there was a reduction in the residual cavity from 300 mL to 60 mL. The patient was discharged on postoperative day 11 after completing 7 days of antibiotic therapy. He had no complaints at the follow-up visit two months later.

In all of the cases, we achieved the primary goal of resolving infection. The length of hospital stay after the procedure ranged from 8 to 11 days, and the antibiotics were discontinued within 7 days in all of the cases. The shortest follow-up period was two months, and the patient showed no signs of recurrent infection. One characteristic we observed was that, contrary to our initial expectation, the vacuum-assisted closure failed to obliterate the entire cavity; however, it appears to promote rapid sterilization of the cavity, which allows closure, even with residual space (Figure 2).

With regard to safety issues, none of the patients developed complications that could be attributed to the procedure or the device. Pain during use of the vacuum-assisted closure, in all of the cases, was adequately controlled by analgesia with opioids (tramadol or codeine) and common analgesics (dipyrone). None of the patients had complaints of chronic pain during outpatient follow-up. To avoid re-exposure to radiation and reduce costs, we chose to follow patients with routine chest X-rays, eliminating the use of postoperative CT scans.

The impression derived from the observation of these three cases is that the technique is feasible, safe, and reasonably effective. Certainly, this small experience, even if combined with the findings of previously published studies, does not serve as conclusive evidence. Further, preferably comparative, studies are needed to determine the true place of this technique in the therapeutic arsenal against pleural empyema.

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