

# Applied Usage and Tips of High Stretch Fixation NPWTi-d for Sternal Osteomyelitis

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**Summary:** Sternal osteomyelitis is a rare but devastating complication of median sternotomy. To achieve good outcomes, it should be diagnosed early and treated appropriately. Standard treatment involves antibiotics, debridement, and reconstruction with flaps. To prevent flap complications and recurrence, the wound bed must be prepared carefully. One approach, a recent development, is negative pressure wound therapy with instillation and dwell time (NPWTi-d), where suction cycles are interspersed with wound instillation with solutions. NPWTi-d is currently cautioned against for large trunk wounds and cavities because it might alter core body temperature. Here, we report a new NPWTi-d dressing technique that is associated with successful reconstruction in two severe sternal osteomyelitis cases with wound sizes of 29×10 and 28×8 cm. This “delay-dressing technique” involves manually pulling the wound edges together; inserting a thin strip of dressing foam; applying dressing film strips from one side of the chest wall to the other, thus placing strong stretching tension on the normal skin around the wound; and then applying NPWTi-d. In our cases, we used the V.A.C. Ulta system for 20 and 17 days. The successful reconstruction in both cases may reflect good wound bed preparation and flap preconditioning due to the mechanical stress imposed by NPWTi-d. Thus, this dressing technique with the V.A.C. Ulta system may be an effective treatment option for sternal osteomyelitis cases. (*Plast Reconstr Surg Glob Open* 2023; 11:e5004; doi: 10.1097/GOX.0000000000005004; Published online 25 May 2023.)

Sternal osteomyelitis (SO) is a severe complication of median sternotomy. It occurs in 0.5%–8.4% of open-heart operations and 1.9% of cases that undergo coronary-artery bypass grafting with bilateral internal thoracic artery grafting.<sup>1,2</sup> It is life-threatening due to the risk of mediastinal sepsis, and the mortality rate is 8.1%–14.8%.<sup>1</sup> Risk factors for SO include patient’s diseases and surgical factors, which decrease the blood supply to the chest wall. To obtain good outcomes, SO must be diagnosed early and treated appropriately.

The standard treatment consists of infection control, debridement, and reconstruction surgery. However, due to numerous risk factors, reconstruction can fail or the infection can reoccur, and complication rate associated with flap surgery is 18.8%–30.0%.<sup>3</sup> To prevent these poor

outcomes, it is essential to conduct careful wound bed preparation (WBP).

An effective WBP technique is negative pressure wound therapy (NPWT). NPWT promotes wound healing by applying mechanical forces that improve angiogenesis.<sup>4</sup> Additionally, NPWT with instillation and dwell time (NPWTi-d) yields better outcomes than standard NPWT, especially in infected wounds, because it can deliver cyclic suction with instilling solutions.<sup>5,6</sup> However, NPWTi-d is cautioned against for large trunk cavities because of the potential risk of altering core body temperature.<sup>7</sup> Here, we report a novel and effective NPWTi-d method for large SO wounds that we designate the “delay-dressing technique.”

## CASES

### Case 1

A 66-year-old man was diagnosed with SO after bilateral internal thoracic artery-coronary-artery bypass grafting for ST-segment elevation myocardial infarction (STEMI). The anterior chest defect size was 29×10 cm after two debridements (Fig. 1A). The wound was dressed with NPWTi-d as follows. Firstly, the wound sides were pushed toward the median side manually to reduce its width. Secondly, a

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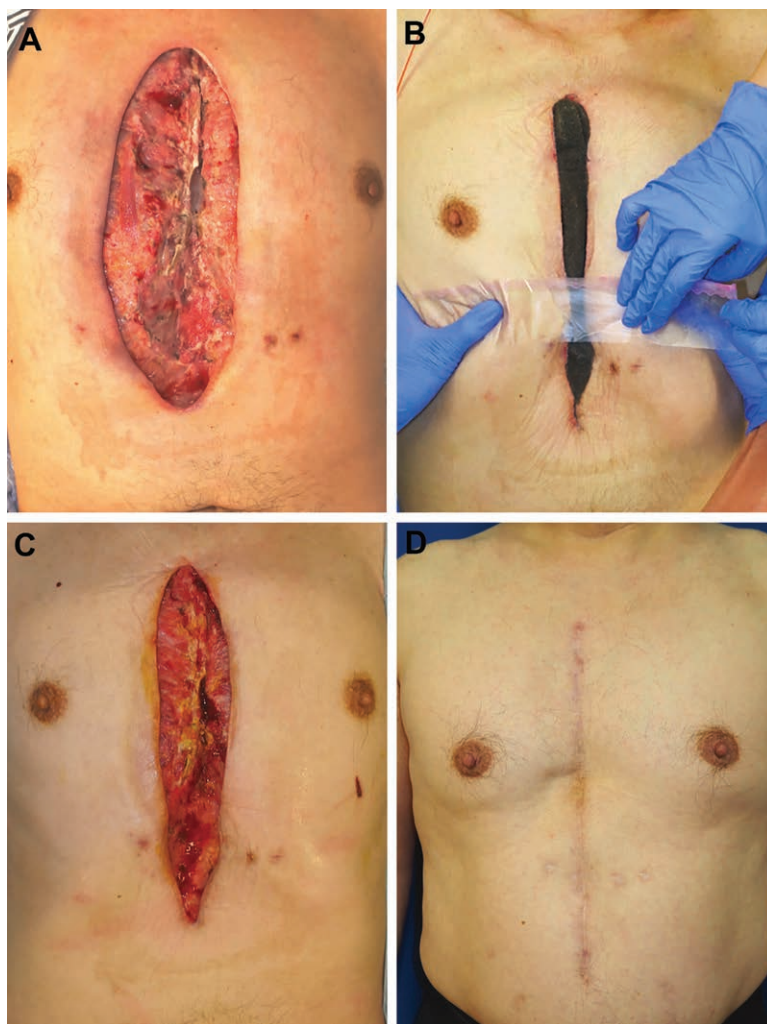
narrow (3 cm wide) strip of dressing foam was inserted. While the wound edges were forcefully pushed toward the midline, a strip of film sheet to the uninjured skin far on the right side of the wound was applied. The film sheet was then pulled to the contralateral side with a strong stretching force that maintained the narrowed wound dimensions (Fig. 1B). This procedure was repeated at intervals along the long axis of the wound. Finally, the wound was covered by a single film sheet drape. NPWTi-d with saline (30–50 ml instillation volume and cycles of 10 minute soak followed by NPWT at – 75 mm Hg for 3 hours) with the V.A.C. Ultra system was then applied for 20 days (Fig. 1C). The defect was covered with a pectoralis major advancement flap, and recurrence has not been observed in the ensuing 3 years (Fig. 1D).

### Takeaways

**Question:** The key problem this study is trying to solve is treatment failure risk in large sternal osteomyelitis (SO).

**Findings:** In this study, we presented two case reports, in which we used high stretch fixation of NPWTi-d in SO wounds to check improved flap reconstruction outcomes where we observed no recurrence or flap complications during the follow-up period.

**Meaning:** When NPWTi-d with our delay-dressing technique is applied to SO wounds, it shows benefits in the treatment of challenging wounds of SO through potential mechanisms of action, including promoting wound bed preparation and flap-preconditioning effects.



**Fig. 1.** Case 1. This is a 66-year-old man who had a defect size of 29×10 cm after two debridements. A, NPWTi-d with the delay-dressing technique was conducted. Thus, the dressing foam was cut to snugly fit the now-narrower defect and inserted into the wound while the first surgeon manually pushed the wound edges of the anterior chest to the median line on both sides. The second surgeon applied a strip of film dressing to the normal skin on one side of the wound and then pulled the film strongly to the contralateral side before attaching it on that side (B). C, The photograph of the preoperative wound, which became narrower. NPWTi-d was conducted for 20 days. Reconstruction with a pectoralis major advancement flap was performed. The view of the patient 3 years after reconstruction is shown in D. Recurrence was not observed.

**Case 2**

A 51-year-old man was diagnosed with SO after bilateral internal thoracic artery-coronary-artery bypass grafting for a non-STEMI. After two debridements, the wound size was 28×8 cm and the V.A.C. Ultra system was applied for 17 days, as described in Case 1. We then covered the defect with a supercharged vertical rectus abdominis muscle flap. No recurrence was observed in the following 4 months.

**DISCUSSION**

The delay-dressing technique is a novel and effective NPWTi-d method for preparing large SO wounds for reconstruction. Despite the large wounds in our cases, this approach was associated with excellent flap reconstruction outcomes. This is supported by a recent study showing that NPWTi-d of sternal wounds yields shorter treatment durations than conventional dressings.<sup>8</sup>

Before reconstructive surgery, infection control such as culture direct antibiotic and wound management including NPWTi-d and debridement were done. Bone sequestrum was removed, but the inner cortical layer of the sternum was kept intact. Therefore, no instability of the chest wall occurred in either case. During the NPWTi-d treatment, the dressing was changed once per week until the WBP was definitely performed and the defect became small enough to be covered by the flap. Simultaneously, wound edge, exudates, serial wound cultures, and blood test results were also checked to determine active ongoing infection symptoms at the wound bed. The stress of dressing changes is significant for patients with a large wound, such as SO, if an instillation leakage occurs. To prevent this, instillation volume can be adjusted according to the defect size.

NPWTi-d usage is cautioned against for large trunk wounds due to potential effects on core body temperature.<sup>7</sup> However, our technique is able to limit this danger by reducing the wound size. Moreover, by stretching and suctioning the adjacent uninjured chest skin, NPWTi-d with our technique may also precondition the flap-donor tissue; preclinical model studies show that noninvasive suction increases the viable flap area.<sup>9,10</sup> This may reflect the ability of external mechanical stress to promote cutaneous angiogenesis.<sup>4,11</sup> Further clinical studies that assess the effect of NPWTi-d on local vascularization are needed. Cupping suction is another skin-preconditioning technique, but it associates with complications such as blistering and necrosis where the device contacts.<sup>10</sup> Because SO patients are prone to ischemic complications, foam-mediated NPWTi-d systems such as V.A.C. Ultra are more suitable for these high risk cases because it is a safer tool to impose mechanical stress.

There are some caveats regarding the use of NPWTi-d for SO. Firstly, in cases where the heart is exposed, it will be necessary to put many layers of nonadherent gauze on the top of the pericardium to prevent NPWTi-d from causing an injury or hemorrhage. Secondly, it is crucial that the cardiovascular surgeon and the plastic surgeon communicate closely before and during the application of NPWTi-d. This is because even if NPWTi-d is carefully

adapted, it could injure the heart or great vessels; if the medicine regimen is changed (eg, by adding an anticoagulant), NPWTi-d could result in devastating hemorrhage. Finally, wounds with complex shapes should be treated as open wounds or subjected to intra-wound continuous negative pressure and irrigation treatment rather than NPWTi-d; this reflects the risk of infection due to stagnation of the solution.

**CONCLUSIONS**

Our study showed that NPWTi-d applied with the delay-dressing technique was associated with good flap outcomes and, thus, may be an effective treatment for SO. This may be a result of the better WBP effect of NPWTi-d and the atraumatic flap preconditioning effect of the delay-dressing technique. These properties are likely to increase the surgical success rate and expand treatment options in SO. We intend to examine these possibilities with more cases.

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**DISCLOSURE**

*The authors have no financial interest to declare in relation to the content of this article.*

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