

## Commentary: Open Your Mind to Open Chest Management

Myeong Su Kim, M.D.<sup>1</sup>, Suk-Won Song, M.D., Ph.D.<sup>2</sup>

<sup>1</sup>Department of Thoracic and Cardiovascular Surgery, Yeungnam University Medical Center, Yeungnam University College of Medicine, Daegu; <sup>2</sup>Department of Cardiovascular Surgery, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

### ARTICLE INFO

Received April 11, 2023

Accepted April 11, 2023

### Corresponding author

Suk-Won Song

Tel 82-2-2019-3384

Fax 82-2-3461-8282

E-mail sevraphd@yuhs.ac

### ORCID

<https://orcid.org/0000-0002-9850-9707>

See Article page 206.



Myeong Su Kim, M.D.



Suk-Won Song, M.D., Ph.D.

Delayed sternal closure (DSC) was first described in 1975 by Riahi et al. [1] to prevent “tight mediastinal syndrome,” which refers to hemodynamic compromise resulting from sternal closure. Other common reasons for DSC are low cardiac output syndrome (sometimes requiring central mechanical circulatory support), bleeding, arrhythmias, and myocardial edema [1]. In this study by Lim et al. [2], published in this issue of *Journal of Chest Surgery*, DSC using a vacuum-assisted closure (VAC) system was performed in 33 out of 353 cardiac surgery patients. This corresponds to 9.3% of patients, indicating that the rate of open chest management (OCM) is very high compared to the 1.1%–4.2% of patients who underwent DSC in other studies [3-5].

Three large observational studies of DSC reported that low cardiac output occurred in 58% of cases, hemodynamic instability in 20%, bleeding in 10%, arrhythmia in 7%, and myocardial edema in 5% [3,6,7]. However, in this study, intractable bleeding was the most common indication for DSC, in 75% of cases. The authors explained that the reason for this was that patients with a high risk of bleeding, such as emergency cases, redo cases, and reoperations due to postoperative bleeding, were included. Additionally, in cases of high bleeding risk, the authors adopted a strategy of prophylactically applying an open sternum even for moderate bleeding that might be controllable for a

safer postoperative course, rather than repeating bleeding control for a long time. Although it would be difficult to establish numerical criteria for indications such as intraoperative bleeding, it seems necessary to reconsider the overall indications of DSC.

Surgeons are concerned that DSC increases the risk of sternal wound infection (SWI), which has a mortality rate of up to 70% if it progresses to mediastinitis. The risk of SWI in patients with DSC is 2%–5%, whereas it is 1%–2% in patients with primary chest closure [7]. It is unclear whether DSC is an independent risk factor for SWI because patients who require DSC have multiple risk factors for sternal complications. Unfortunately, there are currently no recommendations to guide the management of antibiotic prophylaxis in patients with an open chest following cardiothoracic surgery. In 2018, a study was published on antibiotic prophylaxis in patients with OCM with DSC [8]. The researchers concluded that broad-spectrum antibiotic use was not associated with a decrease in sternal surgical site infections, but may be associated with an increase in *Clostridium difficile* infections. Similarly, an extended duration of prophylactic antibiotics was not associated with a decreased incidence of SWI.

In DSC, a widely used technique is to stent open the sternal bone with plastic syringe struts and cover the wound with an adhesive drape film, although there are several

variations [9]. Balasubramanian and Bhama [9] described a technique for DSC in which the subcutaneous tissues and skin are closed, while the sternal bone is bridged open with an orthopedic plate. They proposed that creating a biological tissue barrier over the mediastinum provides superior immune protection in closure using an Esmarch barrier and Ioban drape (3M, St. Paul, MN, USA). In their 29-patient series, there were no cases of sternal wounds or mediastinal infections. In another study, Bakaeen et al. [10] randomly assigned 452 patients to standard DSC or VAC dressing. They reported SWI rates of 5% in the control group but only 2% in the intervention group, indicating that the risk of SWI was reduced to match that of patients with primary sternal closure. Direct skin approximation and closure is a logical approach, but it is often not possible. Using an adhesive drape film might not completely seal the wound and is easily detached by active bleeding. Covering the open mediastinum with a latex membrane sewn to the skin edges carries the disadvantages of damaging the skin through repeated re-explorations, revisions, and loss of sterility. Sterility is lost when dressings leak from ongoing bleeding, raising concerns about infectious complications when the chest is left open for prolonged periods. Airtight sealing of the wound in VAC actively prevents contamination [11].

In this study, both mediastinal pleurae were opened, drainage catheters were placed, the pericardium was reconstructed after gauze packing, and VAC was applied. The procedure was simplified, effective drainage was possible, and irritation of the heart surface due to sternal edges was likely to be avoided. However, it is questionable whether an appropriate degree of sternal opening can be maintained, and the presence of compression of the right ventricle should be checked during gauze packing. As various methods for OCM are introduced, the outcomes are improving, and it is thought that surgeons' threshold for this procedure is decreasing. A randomized trial according to the presence or absence of skin approximation would seem to be an interesting future research topic, and other variables such as microbiology, the negative pressure setting, the frequency of dressing changes, and the total period of VAC will also need to be studied.

## Article information

### ORCID

Myeong Su Kim: <https://orcid.org/0000-0002-1435-6441>

Suk-Won Song: <https://orcid.org/0000-0002-9850-9707>

## Author contributions

All the work was done by Myeong Su Kim and Suk-Won Song.

## Conflict of interest

Suk-Won Song is an editorial board member of the journal. No other potential conflict of interest relevant to this article was reported.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## References

1. Riahi M, Tomatis LA, Schlosser RJ, Bertolozzi E, Johnston DW. *Cardiac compression due to closure of the median sternotomy in open heart surgery*. *Chest* 1975;67:113-4. <https://doi.org/10.1378/chest.67.1.113>
2. Lim HA, Shin J, Jo MS, Chang YJ, Cho DG, Sim HT. *Delayed sternal closure using a vacuum-assisted closure system in adult cardiac surgery*. *J Chest Surg* 2023 Apr 5 [Epub]. <https://doi.org/10.5090/jcs.22.134>
3. Christenson JT, Maurice J, Simonet F, Velebit V, Schmuziger M. *Open chest and delayed sternal closure after cardiac surgery*. *Eur J Cardiothorac Surg* 1996;10:305-11. [https://doi.org/10.1016/s1010-7940\(96\)80087-x](https://doi.org/10.1016/s1010-7940(96)80087-x)
4. Kurazumi H, Suzuki R, Nawata R, et al. *Feasibility of open chest management with modified negative pressure wound therapy immediately after cardiac surgery*. *Interact Cardiovasc Thorac Surg* 2022;35:ivac041. <https://doi.org/10.1093/icvts/ivac041>
5. Yasa H, Lafci B, Yilik L, et al. *Delayed sternal closure: an effective procedure for life-saving in open-heart surgery*. *Anadolu Kardiyol Derg* 2010;10:163-7. <https://doi.org/10.5152/akd.2010.043>
6. Furnary AP, Magovern JA, Simpson KA, Magovern GJ. *Prolonged open sternotomy and delayed sternal closure after cardiac operations*. *Ann Thorac Surg* 1992;54:233-9. [https://doi.org/10.1016/0003-4975\(92\)91375-j](https://doi.org/10.1016/0003-4975(92)91375-j)
7. Boeken U, Assmann A, Mehdiani A, Akhyari P, Lichtenberg A. *Open chest management after cardiac operations: outcome and timing of delayed sternal closure*. *Eur J Cardiothorac Surg* 2011;40:1146-50. <https://doi.org/10.1016/j.ejcts.2011.02.047>
8. Eckardt JL, Wanek MR, Udeh CI, et al. *Evaluation of prophylactic antibiotic use for delayed sternal closure after cardiothoracic operation*. *Ann Thorac Surg* 2018;105:1365-9. <https://doi.org/10.1016/j.athoracsurg.2018.05.046>

- j.athoracsur.2017.12.012
9. Balasubramanian V, Bhama JK. *Technique for “open sternal” chest closure in patients with assist devices and transplant recipients.* JTCVS Tech 2020;2:77-9. <https://doi.org/10.1016/j.xjtc.2020.02.021>
  10. Bakaeen FG, Haddad O, Ibrahim M, et al. *Advances in managing the noninfected open chest after cardiac surgery: negative-pressure wound therapy.* J Thorac Cardiovasc Surg 2019;157:1891-903. <https://doi.org/10.1016/j.jtcvs.2018.10.152>
  11. Sjogren J, Gustafsson R, Wackenfors A, Malmsjo M, Algotsson L, Ingemansson R. *Effects of vacuum-assisted closure on central hemodynamics in a sternotomy wound model.* Interact Cardiovasc Thorac Surg 2004;3:666-71. <https://doi.org/10.1016/j.icvts.2004.08.003>