

Sternal Closure: The Elusive Holy Grail



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Currently, no clear recommendation can be made for the optimal sternal closure technique, on the basis of high-quality evidence [1,2]. In this issue of *Heart, Lung and Circulation*, the paper by Nezafati et al. — *ZipFix Versus Conventional Sternal Closure: One-Year Follow-Up* — reports another attempt to find the holy grail of sternal closure [3]. Despite this study being the first with follow-up to compare the efficacy and complications of Zipfix with conventional steel wire, the study is underpowered to detect any significant difference in infection between the two groups — which is the primary end point that will justify a change in surgical practice.

Following the successful report of an “open” heart operation in 1953, most cardiac surgeons used a bilateral anterior thoracotomy approach to the heart and great vessels; it was a painful approach, and associated with multiple complications [4]. Milton, in 1897, was the first to suggest the use of median sternotomy [4]. In 1957, median sternotomy affirmed its superiority; it turned out to be the standard incision for open heart surgery around the world, and has continued so until today [4]. The surgeon can access the entire heart and control the whole operative field, which are undeniable advantages (Figure 1). Sternotomy is safe and efficient, and is considered to be the gold standard for cardiac surgery.

Thanks to current hospitals’ hygiene standards and the use of prophylactic antibiotics, technique-related complications, such as postoperative sternal dehiscence with instability and wound infections, are rare, and depend on both surgeon and patient-related risk factors. Surgeon experience and techniques used (bilateral mammary harvesting), as well patients’ risk factors such as osteoporosis, obesity, diabetes have an impact on the prevalence of complications [5].

Closure of the median sternotomy incision is routinely performed with parasternal wires, and any associated sternal wound infections can be superficial or deep [6]. The former (superficial wound infection) occurs with an incidence rate of 3–8% [7]; deep infection, known as mediastinitis, occurs at a rate of only 1–3%, but is associated with a high mortality rate of up to 10–35% [8]. Considering the large number of patients undergoing open heart surgery annually, a large number of deaths related to wound infection must be seen as avoidable and unnecessary. Apart from lowering overall mortality and morbidity, reducing the occurrence of infection would also reduce costs, by avoiding further surgical and pharmacological therapies and shortening hospital stay. Economic aspects of mediastinitis and sternal osteomyelitis were calculated in a matched case–control study: in Germany in the years 2006–2008, the median costs of a CABG case were reported to be EUR 36,261 per infected patient, and EUR 13,356 per patient without infection ($p < 0.0001$) [9].

Stable sternal closure has been suggested to be an important factor in reducing the incidence of the serious problem of wound infection, as well as the incidence of postoperative pain and wound non-union. Historically, in 1977, Robicsek and colleagues proposed a technique to prevent sternal separation in patients undergoing cardiac surgery [10]. On the basis of this initial report with a small number of patients, the technique has been widely accepted: the Robicsek technique makes intuitive sense, as do the numerous published variations: i.e., that with the use of lateral reinforcement, it is unlikely the circular closure wires would cut through bone, with less chance of instability. However, the Robicsek technique is relatively labour-intensive, and during the last several decades, hundreds of articles on the topic of sternal closure have been published, with most authors proposing

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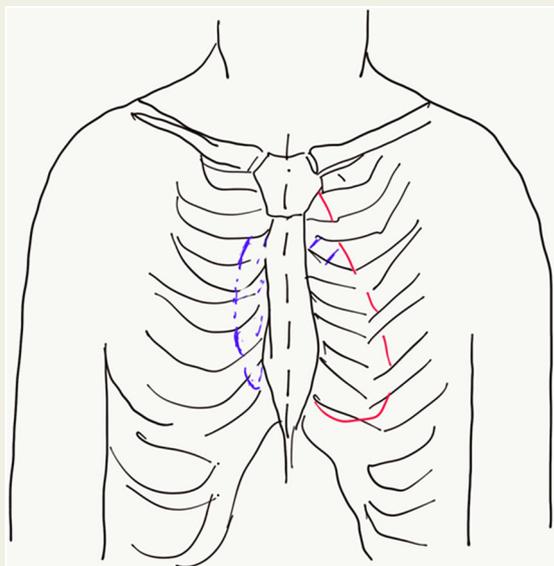


Figure 1 Sternotomy allow access to all cardiac chambers as well as ascending aorta and proximal arch.

new closure techniques, of potential superiority to current routine, again on the basis of small case series. [7] Unfortunately, there have only been a few randomised trials. Pinotti and colleagues published a meta-analysis of seven randomised, controlled trials involving more than 2,000 patients comparing simple closure with variations of the Robicsek method. They found little difference in outcome [11]. Despite the absence of clear benefit over simple closure, the Robicsek method is a class IIa recommendation for the prevention of sternal wound complications.

Nezafati et al. studied another closure technique based on the concept of rigid bone fixation [3]. However, it will be the new paradigm offered by studying the biomechanical stability of the sternal closure techniques that will help in finding the optimal closure method, and in establishing a solid basis for finding a solution to this problem [12,13]. To date, none of the current studies have looked at a three dimensional (3D) dynamic model. This may be the most rational way of looking at the forces affecting the sternum during recovery from cardiac surgery — by offering an understanding and

measurement of motion at the sternal edges during dynamic upper limb and trunk tasks, to better inform future sternal precautions and optimise postoperative recovery. Motion at the sternal edges could be measured using ultrasound, which has been demonstrated to be a clinically valid and new reliable measure in patients following cardiac surgery.

Although some of the new fixation methods continue to be tested, our understanding of the basic forces at play and the need for robust sternal closure is still incomplete [13]. Ideally, what we are searching for or anticipating is a fool-proof, simple, fast, and rigid fixation method that is also cost effective that could be applied routinely to cardiac surgical patients around the world.

References

- [1] Omer S. The quest for ideal sternal closure: not as simple as it sounds. *J Thorac Cardiovasc Surg* 2018;156(4):1587–8.
- [2] Veeramachani N. The optimal sternal closure technique: still elusive. *J Thorac Cardiovasc Surg* 2018;156(1):187.
- [3] Nezafati P, Shomali A, Kahrom M, Tehrani SO, Dianatkah M, Nezafati MH. ZipFix versus conventional sternal closure: one-year follow up. *Heart Lung Circ* 2019;28(3):443–9.
- [4] Dalton ML, Connally SR, Sealy WC. Julian's reintroduction of Milton's operation. *Ann Thorac Surg* 1992;53(3):532–3.
- [5] Rupprecht L, Schmid C. Deep sternal wound complications: an overview of old and new therapeutic options. *Open J Cardiovasc Surg* 2013;6:9–19.
- [6] Cicek S. Sternal closure: wires are still the king! *J Thorac Cardiovasc Surg* 2018;156(4):1596–7.
- [7] Alhalawani AM, Towler MR. A review of sternal closure techniques. *J Biomater Appl* 2013;28(4):483–97.
- [8] Sharma M, Berriel-Cass D, Baran Jr J. Sternal surgical-site infection following coronary artery bypass graft: prevalence, microbiology, and complications during a 42-month period. *Infect Control Hosp Epidemiol* 2004;25(6):468–71.
- [9] Mokhtari A, Sjogren J, Nilsson J, Gustafsson R, Malmstro M, Ingemansson R. The cost of vacuum-assisted closure therapy in treatment of deep sternal wound infection. *Scand Cardiovasc J* 2008;42(1):85–9.
- [10] Robicsek F, Duagherty HK, Cook JW. The prevention and treatment of sternum separation following open-heart surgery. *J Thorac Cardiovasc Surg* 1977;73(2):267–8.
- [11] Pinotti KF, Cataneo DC, Rodrigues OR, Cataneo AJM. Closure of the sternum with anchoring of the steel wires: systematic review and meta-analysis. *J Thorac Cardiovasc Surg* 2018;156(1):178–86.
- [12] Cheng W, Cameron DE, Warden KE, Fonger JD, Gott VL. Biomechanical study of sternal closure techniques. *Ann Thorac Surg* 1993;55(3):737–40.
- [13] Saito T, Iguchi A, Sakurai M, Tabayashi K. Biomechanical study of a poly-L-lactide (PLLA) sternal pin in sternal closure after cardiothoracic surgery. *Ann Thorac Surg* 2004;77(2):684–7.