Sternal closure after median sternotomy: a new technique using titanium hooks and wires applied parasternally

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Abstract

OBJECTIVES: Osteosynthetic closure of the chest after median sternotomy is usually performed with steel wires. We describe, for the first time, a case series in which titanium hooks were implanted from the sternal surface in patients who required secondary or additional stabilization. In comparison to the classic wires, the diameters of the hooks are approximately three times bigger and therefore reduce the risk of cutting through the bones. Additionally, there is no need to dissect retrosternal adhesions, which may reduce the risk of injuring mediastinal tissues.

METHODS: The hooks are shaped like fishing hooks and can be inserted parasternally into the intercostal spaces. They can be pulled to the contralateral side of the sternum by the attached wires and then intertwined with a second hook.

RESULTS: In 13 patients, the system was used to provide additional stabilization, while in two patients the hooks were implanted for exclusive stabilization of sternal fractures. In all cases but one, the implantation was able to eliminate the sternal problems. No infections, necrosis or bleeding of neighbouring tissues occurred. One patient developed chronic sternal infection, which necessitated explantation of the hooks.

CONCLUSIONS: This sternal closure system using titanium hooks inserted parasternally is an effective alternative to conventional techniques and may increase stability of the breastbone and reduce the risk of injury to retrosternal tissues.

Keywords: Sternal closure • Titanium hooks • Additional stabilization

BACKGROUND

The use of steel wires is the most common technique for sternal closure after median sternotomy. There are, however, imminent risks when using such wires [1, 2]. Owing to traction and shear forces during thoracic motion, the wires may fracture or even cut through the sternum, necessitating sternal refixation. Another, less severe, problem is that the wires may cut the sternum incompletely and, by loosening the sternal stability, they may result in prolonged sternal healing and pain and even increase the risk of sternal infections. Usually, such complications result in prolonged hospitalization and often cause mediastinitis and sternal osteomyelitis; both these complications result in increased morbidity and mortality. To date, many techniques have been described for preventing or treating such complications [3–5]. Most of these techniques require reopening of the sternal cleft and the dissection of the dorsal parts of the sternum in order to reuse steel wires or sternal bands. It is obvious that by doing so, the adjacent structures, such as bypass grafts, the heart or the lungs, may be injured. In contrast, Negri et al. reported the suprasternal insertion of nitilium clips, although this resulted in an elastic bone fixation [6].

We report the first clinical experience with a new sternal closure system, which makes retrosternal dissection redundant and allows sternal refixation by use of titanium wires connected to sternal hooks, which are inserted parasternally without prior preparation of the sternal cleft. The system may be used alone or in addition to other sternal closure systems.

MATERIALS AND METHODS

We used the ASCS® System (ASCS atraumatic Sternum Closure System; KS Handelsvertretung Produktinnovation, Bad Homburg, Germany). The system consists of titanium hooks, which are connected to titanium wires (Fig. 1). The hooks are available in three different sizes (S, M and L). The hooks are shaped in such a way that they grip the lateral sides of the dehiscent sternal halves in the respective intercostal spaces. The hooks have a larger diameter in comparison to conventional steel wires, which reduces the risk of cutting through the sternum. After parasternal insertion (one hook on each side of the divided sternal halves) in the intercostal spaces, the attached titanium wire is pulled to the respective contralateral side and intertwined with the...
corresponding wire of the other side. The hooks may be used for horizontal wiring or in a figure-of-eight-like technique.

RESULTS

Fifteen patients were treated with the ASCS® System. In 10 patients, the system was used for restabilization of the sternum after primary conventional chest closure with steel wires when the wires had loosened and the sternum fractured (Video 1). In three patients, the ASCS® System was used prophylactically owing to extensive osteoporosis of the bone (Fig. 2). The ASCS® System was used in two cases for stabilization of a fractured sternum (Fig. 3). There was only one patient who developed a chronic sternal infection after being treated with the ASCS® System. This was most probably due to bilateral harvesting of the mammary arteries during coronary artery bypass grafting. In this case, the titanium hooks of the ASCS® System had to be explanted. In all other cases, the system worked perfectly. We did not notice bleeding or injury of adjacent tissues. There was no incidence of wire rupture or system failure. We did, however, explant one system 6 months postoperatively due to persistent chest pain (Fig. 4).

DISCUSSION

The ASCS® System is effective for both primary and secondary sternal stabilization. Its use results in a stable osteosynthesis, even in patients suffering from sternal pseudoarthrosis, without the necessity of reopening the retrosternal space to position the usual steel wires safely. The only additional preparation to be done is the superficial removal the pseudoarthrotic scar tissue in the sternal cleft. By using the ASCS® System, restabilization becomes technically easy and is less dangerous for the patients,
considering the fact that sternal restabilization using steel wire increases the mortality rate.

In our opinion, the ASCS® System addresses some crucial problems that can arise during secondary sternal restabilization by avoiding any dangerous manipulations to adjacent critical tissues. Its use is simple and does not require a special learning curve. The system should always be considered to be the first choice when restabilization of the sternum becomes necessary.

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Conflict of interest: none declared.

SUPPLEMENTARY MATERIAL

Supplementary material is available at ICVTS online.

REFERENCES


eComment. Is the sternal closure technique using titanium hooks and wires cost-effective?

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The publication by Kilian et al. proposes a new technique for sternal closure in patients with secondary or additional stabilization [1]. They successfully performed the new technique using titanium hooks and wires in 15 patients and revealed very satisfactory results. The most striking feature was the possible avoidance of substernal dissection in redo cases with sternal instability, thereby decreasing the risk of graft or myocardial/pulmonary injury. We congratulate the authors for their effort and successful results.

We believe that there is one more topic to be emphasized on this subject. It is very well known that substernal dissection in redo cardiac surgery including sternal repair may lead to injury in adjacent structures. In this context, the use of thermoreactive nitinol clips was reported recently by our group [2]. We documented the ease of the technique due to the nature of the material and the parasternal application procedure. Moreover, we also reported the cost-effectiveness of the method. From the early years of cardiac surgery, various reports documenting sternal re-closure techniques have been published. The most frequently employed technique is still the Robicsek weave [3]. It is simple, cheap and objectively effective. The only drawback is the need for substernal re-dissection. In our study, we also compared the costs of sternal re-closure methods avoiding substernal re-dissection. The cost for thermoreactive nitinol clip implantation was $550; $700–1400 for rigid-plate fixation and $8500 for the transverse sternal-plating system. We concluded that thermoreactive nitinol clip implantation was more advantageous. We think that the authors should also have done a cost analysis to provide readers with a possible comparison between the mentioned techniques.

Conflict of interest: none declared.

References


eComment. Multiple approaches for sternal dehiscence

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We read with great interest the paper by Kilian et al., investigating the efficacy of a novel technique using specially designed titanium hooks for sternal closure [1]. In the majority of their patients, the Atraumatic Sternal Closure System system was...