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Sternal pseudoarthrosis after resternotomy treated with the Strasbourg Thoracic Osteosyntheses System: a case report

Krūtinkaulio pseudoartrozės po resternotomijos gydymas Strasbūro krūtinės osteosintezės sistema: klinikinis atvejis

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Sternal dehiscence is a serious complication after general thoracic and cardiac surgery. Sternal resuturing, performed by simple rewiring or technical modification of rewiring, can fail overall when the bone quality is poor or the sternum is completely destroyed. A number of different sternal closure systems consisting of plates, screws, clips, and titanium bars have been recently introduced to treat the complicated sternal dehiscence. We describe the use of the Strasbourg Thoracic Osteosyntheses System (STRATOS) to treat complicated sternal dehiscence causing chest and back pain, sternum and chest instability, which was applied for the first time in Lithuania.

Key words: sternotomy, sternal pseudoarthrosis, sternal osteosynthesis, chest instability, STRATOS.

Introduction

Middle sternotomy has been the most common access to the heart and the anterior mediastinum since its introduction into clinical practice by Julian *et al*. in 1957 [1]. The closure of median sternotomy is usually done by wiring with stainless steel wires in a simple interrupted or figure-of-eight fashion [2, 3]. The incidence of sternal dehiscence with or without infection ranges from 0.5 to 5.0 perc. and is a serious complication after surgery. The risk of sternal complications is increased by osteoporosis, obesity, chronic obstructive pulmonary disease (COPD), diabetes, intake of corticosteroids. Technical mistakes in sternotomy or even sternal closure, break in sterility or a prolonged operative time can contribute to wound infection or a sternal non-union [4, 5]. Sternal reoperation can be performed by simple rewiring or technical modification of rewiring as described by Robicsek and colleagues [3]. When the bone quality is poor, the above classical approaches can fail; therefore, the recently introduced rigid fixation systems can be used for sternal stabilization [6, 7]. We describe the case of a sternal dehiscence after unsuccessful rewiring, treated

with the implant of the Strasbourg Thoracic Osteosyntheses System (STRATOS).

Case presentation

A 70-year-old man with primary arterial hypertension, osteoporosis, and coronary artery disease underwent a CABG procedure via transsternal approach on November 7, 2007. The fluid in the left pleural space was diagnosed one week postoperatively. Thoracocenthesis revealed left-sided chylothorax. It was managed by multiple thoracocentheses with a good result. However, the symptoms of dyspnoea and chest pain did not vanish. He was admitted to hospital once again on May 20, 2008. The main complaint was pain in the chest, which became more intensive, especially while coughing. Echocardiography and coronary artery investigation showed no pathology. On chest X-ray, only one broken sternal wire was observed. For that reason, it was decided to perform the rewiring of the sternum. The operation was performed on May 21, 2008. The postoperative course was uneventful. However, the pain in the chest and the shortness of breath did not disappear. The patient took painkillers of different origin, visited specialized clinics for pain treatment; however, the symptoms persisted.

The chest CT scan was performed on September 9, 2011, which revealed the true origin of the complaints. The presence of a total sternal pseudoarthrosis was evaluated with a 20 mm wide separation of the sternal edges in the lower part of the bone (Fig. 1). Besides, X-ray showed that six of the eight sternal wires were broken (Fig. 2). It became evident that a simple or any of the modifications of rewiring technique offered a very low benefit. Thus, it was decided to use titanium implants for sternal reinforcement.

The operation was performed on April 17, 2012, under general anaesthesia. The prior median sternotomy incision was opened, and six broken steel wires were removed. The major pectoral muscle was elevated bilaterally, from the insertion along the medial aspects of the ribs to the mid-clavicle line. The degree of sternal separation and bone vitality was assessed. The edges of the sternal bone were mobilized and cleaned from fibrous tissue until the bleeding from the bone marrow was visible. Then, the stabilization of the sternum was performed with a STRATOS titanium implants (Strasbourg Thoracic Osteosyntheses System; MedXpert,

Figure 1. Preoperative CT-scan of the sternum. Distance of approximately 20 mm between bone edges is clearly visible in the lower part of the sternum

Figure 2. Six broken wires of eight are seen on preoperative chest X-ray

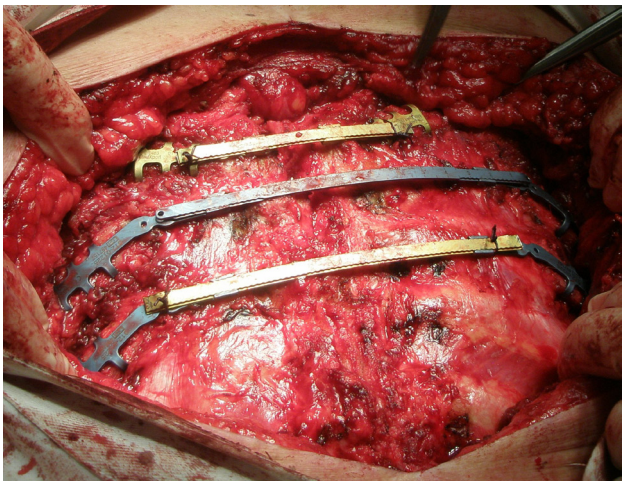

Figure 3. The final view of the transverse thoracic stabilization. All three titanium bars and six clips are in place. The picture was performed from the cranial aspect

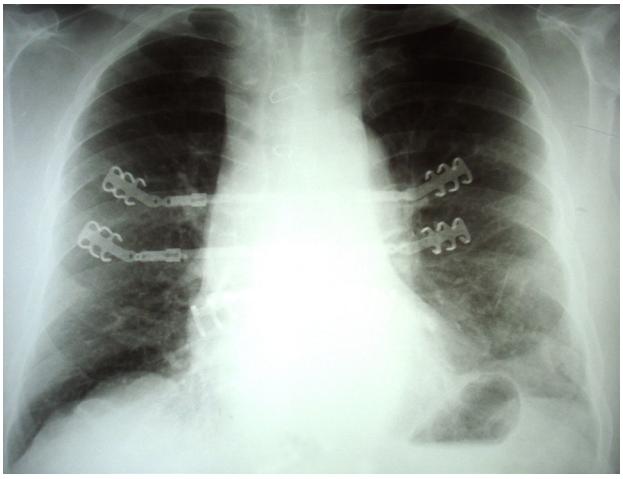

Figure 4. Postoperative chest X-ray showing the implants on the day of discharge

Heitersheim, Germany). It was decided to use three bars and six clips on the fourth, fifth, and sixth ribs on both sides. To allow the clip to sit directly on the rib, the intercostal muscle and bundle were elevated subperiostally at the clip site. Then the clip was crimped to the rib with special fixation pliers. The correct angle of the clip tail was modified with special instruments. The titanium connecting bar was then cut to the size needed using carbide-tipped pliers and was hand-contoured to the shape of the chest wall. The bar was secured to the clips by crimping. Finally, a stitch of 1/0 vicryl was used for an additional fixation of the clip to the rib. The technique did not require screws, cement or glues (Fig. 3). The two drainage tubes were left, and the muscle flap was laid on over the titanium reconstruction and reattached. The fat and skin layers were then closed. Negative pressure suction (25 cm H_2O) was connected to the drainage tubes. The blood loss was <200 ml, and the operating time was 3 hours and 10 minutes.

The patient was extubated after approximately 4 hours. Antibiotics (cefuroxim 1.5 g × 2) were administered for 48 hours postoperatively. Drainage tubes were removed on the fifth postoperative day. He made an excellent recovery with daily physiotherapy to encourage shoulder movements (Fig. 4). The wound healed without complications. The first four postoperative weeks he was asked not to move his arm more than 90 degrees from the neutral anatomical position and not to drive a car for the first two weeks. He was discharged with oral analgesics on postoperative day 10.

The patient was seen in the out-patient department two and four months postoperatively. He is doing well and has no previous complaints concerning chest instability.

Discussion

Sternal dehiscence is a rare but serious complication after sternotomy. In case of reduced bone vitality, efforts of sternal refixation can pose a challenging problem. When the bone is very osteopenic, simple techniques of rewiring are associated with the high rate of recurrence. In such cases, muscle flaps or mesh grafts can be used to close the sternal defects [8]. However, in the long-term, many patients complain of chronic pain in the chest and back due to sternal instability [9]. It is generally accepted that limiting the relative motion between the broken bone segments is beneficial for a rapid bone healing. Moreover, the approximation of the sternal edges is mandatory in order to reduce tension on the pectoralis muscular flap, thus facilitating healing. Therefore, a solid thoracic refixation is preferable [10]. The sternal closure systems consisting of titanium reconstruction plates, cables, and screws perform a transverse rib-to-rib stabilization without the adhesiolysis of the substernal area, extending the zone of fixation beyond the fractured sternum to the ribs laterally, where the bone quality should be better [5].

The STRATOS has been recently introduced to treat chest wall deformities such as *pectus excavatum*, to stabilize the fractures after a thoracic trauma or to reconstruct the chest wall after removal of a tumoral mass surgically [9, 10].

Each implant consists of two rib clips straight-united by a connecting titanium bar. The three different angulations of the clips and the adjustable length of the connecting bar allow using this system for any anatomical situations. The use of titanium as a biological prosthesis is well established. Titanium rapidly forms an oxide layer which is highly corrosion-resistant. It has the highest strength-to-weight ratio of all metals. Titanium can integrate with a bone. This is reliant on osteoblasts attaching to the titanium surface and eventually forming a mineralized bone in continuity with the implant, which then is less likely to "loosen" over time [9, 11].

Another advantage of titanium is its relative non-interference with cross-section imaging. It produces fewer artefacts than steel, because it is less dense; this is important, since reduced artefacts allow a more accurate three-dimensional reconstruction which may be important in the subsequent clinical management. Besides, titanium is non-ferromagnetic, allowing patients to be examined by the magnetic resonance imaging (MRI) [12].

Conclusion

This is a single report of using a novel system in Lithuania. The development and introduction of a new technology is often expensive, but it may be justified if associated with better functional outcomes. We propose the use of STRATOS to treat a complicated sternal dehiscence, particularly in cases when conventional methods have failed. This system is effective in stabilizing the chest wall, minimizing the pain and facilitating a quick healing of the wound.

Disclosure

The authors wish to disclose that they have no financial relationship with the companies manufacturing the products described in this presentation.

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