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

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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 intoduced 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 is the most common access to the heart and 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% and it 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 prolonged operative time can contribute to wound infection or sternal non-union (4, 5). Sternal reoperation can be performed by

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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 the 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 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 good results. 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 rewiring of the sternum. The operation was performed on May 21, 2008. The postoperative course was uneventful. However, the pain in the chest and 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 total sternal pseudoarthrosis was evaluated with a 20 mm width separation of the sternal edges in the lower part of the bone (Fig. 1). Besides, X-ray showed that six of eight sternal wires were broken (Fig. 2). It became evident that simple or any of modifications of rewiring technique offered a very low benefit. Thus, it was decided to use titanium implants for sternal reinforcement.

The operation was performed under the general anaesthesia on April 17, 2012. The prior median sternotomy incision was opened and six broken steel wires were removed. The major pectoral

Fig. 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

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

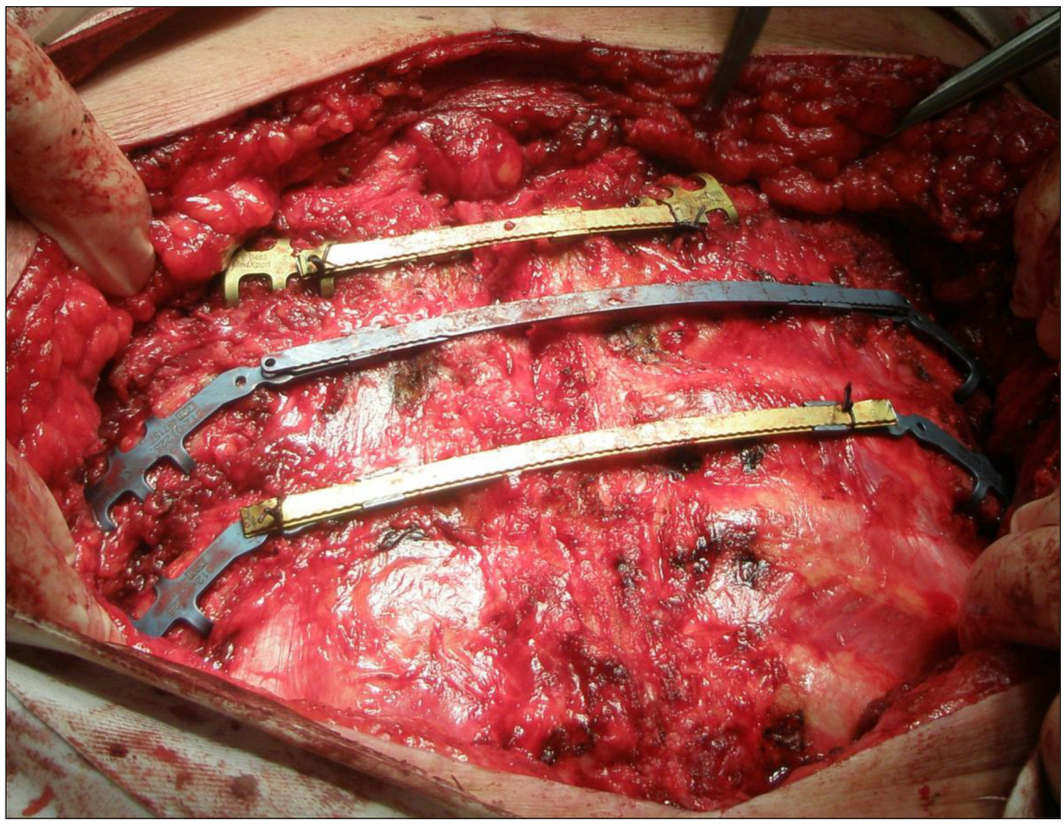

Fig. 3. The final view of the transverse thoracic stabilisation. All three titanium bars and six clips are in place. The picture was performed from the cranial aspect

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 the fibrous tissue until bleeding from the bone marrow was visible. Then the stabilization of the sternum was performed with STRATOS titanium implants (Strasbourg Thoracic Osteosyntheses System; MedXpert, 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 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. For the first 4 postoperative weeks he was asked not to move his arm more than 90 degrees from the neutral anatomical position; and not drive a car for the first two weeks. He was discharged with oral analgesics on postoperative day 10.

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.

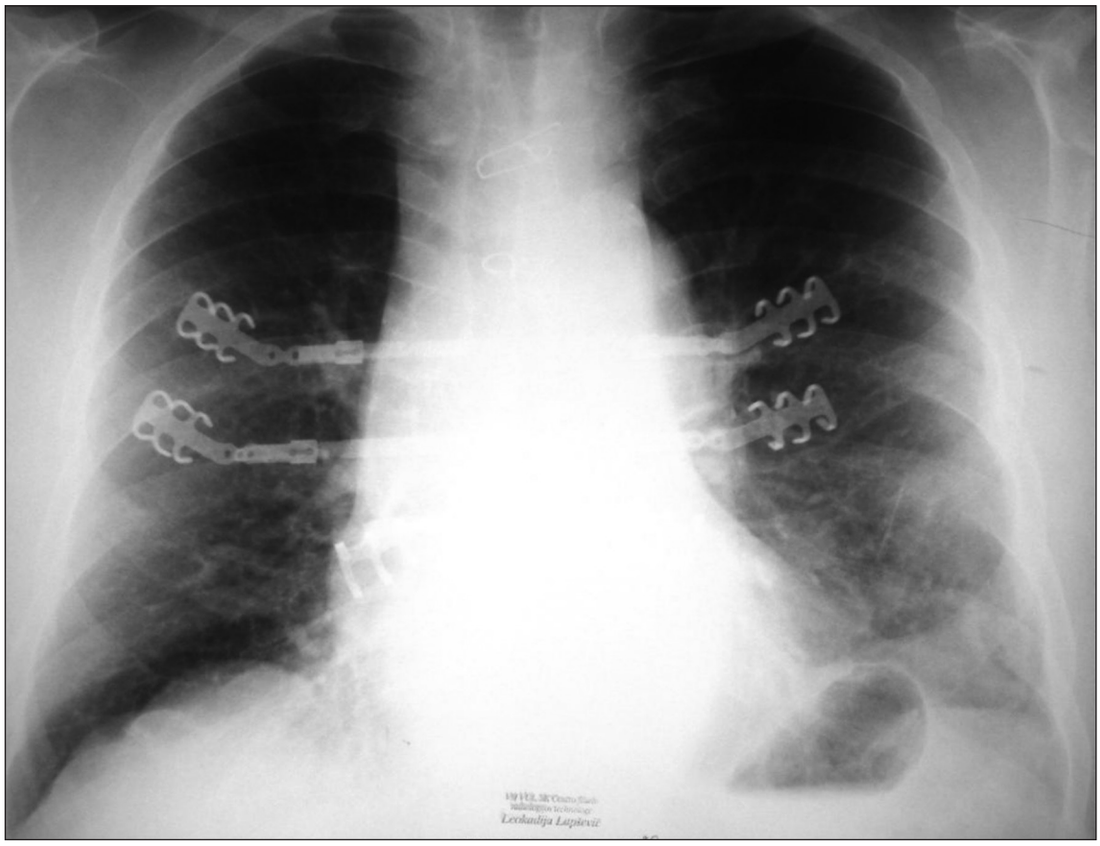

Fig. 4. Postoperative chest X-ray showing the implants on the day of discharge

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 relative motion between broken segments of the bone is beneficial for rapid bone healing. Moreover, 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 the chest wall deformities such as *pectus excavatum*, to stabilize the fractures after 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 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 that is highly corrosion-resistant. It has the highest strength-to-weight ratio of any metal. Titanium can integrate with bone. This is reliant on osteoblasts attaching to the titanium surface and eventually forming 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 permit more accurate three-dimensional reconstruction, which may be important in subsequent clinical management. Besides, titanium is nonferromagnetic, allowing patients to be examined with magnetic resonance imaging (MRI) (12).

CONCLUSIONS

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

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References

1. Julian OS, Lopez-Belio M, Dye WS, Javid H, Grove WJ. The median sternal incision in intracardiac surgery with extracorporeal circulation: a general evaluation of its use in heart surgery. Surgery. 1957; 42: 753.
2. Losanoff JE, Jones JW, Richman BW. Primary closure of median sternotomy: techniques and principles. Cardiovasc Surg. 2002; 10: 102–10.
3. Robicsek F, Daugherty HK, Cook JW. The prevention and treatment of sternum separation following open-heart surgery. J Thorac Cardiovasc Surg. 1977; 73: 267–8.
4. Loop FD, Lytle BW, Cosgrove DM, Mahfood S, McHenry MC, Goormastic M, et al. J. Maxwell Chamberlain memorial paper. Sternal wound complications after isolated coronary artery bypass grafting: early and late mortality, morbidity and cost care. Ann Thorac Surg. 1990; 49: 179–87.
5. Casha AR, Manche A, Gauci M, Camillieri-Podesta MT, Schembri-Wismayer P, Sant Z, et al. Placement of trans-sternal wires according to an ellipsoid pressure vessel model of sternal forces. Interact Cardiovasc Thorac Surg. 2012; 14: 283–7.
6. Voss B, Bauernchmitt R, Will A, Krane M, Kross R, Brockmann G, et al. Sternal reconstruction with titanium plates in complicated sternal dehiscence. Eur J Cardiothorac Surg. 2008; 34: 139–45.
7. Cicilioni Jr. OJ, Stieg III FH, Papanicolaou G. Sternal wound reconstruction with transverse plate fixation. Plast Reconstr Surg. 2005; 115: 1297–303.
8. Mansour KA, Thourani VH, Losken A, Reeves JG, Miller Jr. JI, Carlson GW, Jones GE. Chest wall resections and reconstruction: a 25-year experience. Ann Thorac Surg. 2002; 73: 1720–6.
9. Claes L, Eckert-Hubner K, Augat P. The effect of mechanical stability on local vascularization and tissue differentiation in callus healing. J Orthop Res. 2002; 20: 1099–105.
10. Coonar AS, Qureshi N, Smith I, Reisberg E, Wihlm JM. A novel titanium rib bridge system for chest wall reconstruction. Ann Thorac Surg. 2009; 87: e46–8.
11. Girsowicz E, Falcoz PE, Santelmo N, Massard G. Does surgical stabilization improve outcomes in patients with isolated multiple distracted and painful non-flail rib fractures? Interact Cardiovasc Thorac Surg. 2012; 14: 312–5.
12. Lee MJ, Kim S, Lee SA, Song HT, Huh YM, Kim DH, et al. Overcoming artifacts from metallic orthopedic implants at high-field-strength MR imaging and multi-detector CT. Radiographics. 2007; 27: 791–803.

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KRŪTINKAULIO PSEUDOARTROZĖS PO RESTERNOTOMIJOS GYDYMAS TAIKANT STRASBŪRO KRŪTINĖS OSTEOSINTEZĖS SISTEMĄ: ATVEJO PRISTATYMAS

Santrauka

Krūtinkaulio nesuaugimas yra rimta komplikacija po krūtinės ar širdies chirurginių operacijų, kai yra atlikta sternotomija. Pakartotinis krūtinkaulio susiuvimas vielomis paprasta ar modifikuota siūle gali būti nesėkmingas, jei kaulo kokybė prasta arba krūtinkaulis yra stipriai suardytas. Pastaruoju metu krūtinkaulio nesuaugimą po sternotomijos bandoma gydyti

pasitelkus įvairiausias stabilizuojančias priemones: plokšteles, sraigtus, titaninius implantus, sąvaržas. Mes pateikiame atvejį, kai komplikuotas krūtinkaulio nesuaugimas, sukėlęs krūtinės ir nugaros skausmus, krūtinės nestabilumą, buvo gydytas pirmą kartą Lietuvoje taikant Strasbūro krūtinės osteosintezės sistemą (STRATOS).

Raktažodžiai: sternotomija, krūtinkaulio pseudoartrozė, krūtinkaulio osteosintezė, krūtinės sienos nestabilumas, STRATOS