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CASE REPORT

Sternum Resection and Chest Wall Reconstruction with Metaacrilate Implant in Tuberculosis

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Abstract We report a case of successful sternum and ribs/cartilage resection and chest wall reconstruction with a methacrylate implant produced using a three-dimensional model in a patient with a tuberculotic mass in this region. Clinical and radiologic follow-up 2 years after surgery showed excellent cosmetic and functional outcome.

Keywords Tuberculosis · Strnum · Chest wall · Implant · Metaacrilate

Introduction

A 54-year-old man was admitted to University Hospital in Kragujevac, Serbia, in February 2009 due to cough, hemoptysis, pain in the region of sternum, and the appearance of the tumor-like lesion in the region of sternum. Clinically, an infiltrative change at the junction of manubrium and sternal body of approximately 8 cm was movable with respect to skin but fixed to underlying tissues, seemingly infiltrating the second and the third intercostal cartilages bilaterally, as well as pectoralis major muscle bilaterally. Chest X-rays showed a suspect infiltrative lesion at the anterior segment of the right upper lobe. Cytologic, bacteriologic, BK, and LOW sputum investigations were all negative. Bronchoscopically, at the level of opening of middle lobe bronchus, at its lateral wall, there was a beacon-like tissue. Bronchoscopy with biopsy as well as percutaneous biopsy showed nonremarkable pathology finding, with no tumor cells in the specimen.

On CT scan, a mass measuring 56 mm×65 mm on the axial cross-section and 78 mm superiorly–inferiorly was detected. It led to manubrium and a part of the sternum body destruction, as well as of both pectoralis major muscles and subcutaneous tissue. At its posterior aspect, the tumor mass infiltrated parietal pleura and anterior segment of the right lung. Large zones of liquefaction and necrosis were also observed. The bronchus for anterior segment of the right upper lobe was retracted by traction. No signs of mediastinal lymphadenopathy were noted (Fig. 1a and b).

After a consultation with a thoracic surgeon, it was decided to surgically approach the patient. Preoperative investigations, including clinical, laboratory, ultrasound, spirometry, scintigraphy as well as repeated sputum investigation and skin TB tests, were all negative. Due to anticipated substantial tissue defect that would have occurred with extensive surgery of the affected region, we considered extirpation of the tumor-like lesion of the region of sternum followed by immediate implantation of the suitable material

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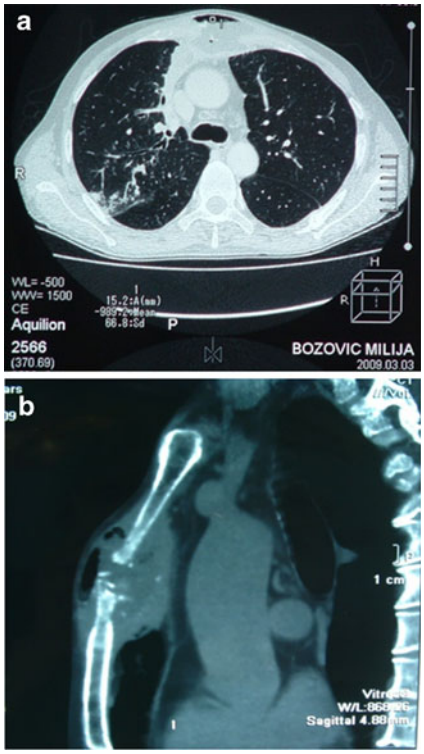

Fig. 1 **a** and **b** Initial CT scans of the chest showing infiltration in sternal region (CT, computed tomography)

which would mimic normal tissues in their morphological and functional aspects. School of Mechanical Engineering, University of Kragujevac, was consulted to seek advice about the type of the material to be used (to enable long-term duration as well as to prevent any host rejection), ways to produce appropriate shape deemed necessary for successful implantation as well as necessary interface between clinical (imaging, surgery) and technical (material, shape) aspects of the treatment plan.

The casting mold for sternum implant manufacturing is fabricated using 3D models created in CAD software, exported in STL format and then processed by software driver for printing the model (Fig. 2a–e) on a 3D printer. After printing and solidification, the parts were removed from the printer chamber and dried to provide adequate mechanical properties. The final 3D models are used for fabrication of polyurethane plastic mold. The implants were then created by filling the polyurethane plastic mold with the standard prosthetic material (75 % methyl methacrylate–styrene copolymer and 15 % polymethyl–metacrylate). Prosthetic material was applied in the mold cavity which was completely filled and mold was additionally mechanically compressed. After solidification, the implant was removed from the mold, finished and sterilized prior to surgery.

Surgery was performed in March 2009 (Fig. 3a–d). After skin and soft tissue cut, the manubrium and the upper half of the sternum together with costal cartilages, bilaterally, from the first to the fourth cartilages were first prepared and then resected. Histologic extempore diagnosis was unremarkable. Adhesiolysis and wedge resection of the anterior segment of the upper right lobe using GIA stapler of 100 mm was done. The right pleural space was washed up, thorough hemostasis ensured and the mediastinum drained. Chest wall defect was closed with mesh wire, sutured to the chest wall with Prolene 0 and then methacrylate implant was placed in situ. Implant was fixed to the ribs with the wire. Mesh wire was placed above the implant which was sutured to the chest wall using Prolene 0. The chest wall was then closed. The patient was on mechanical ventilation for 24 h, and then he was extubated and continued with spontaneous breathing with normal vital signs. The patient was discharged on the ninth day after operation, with the final histopathology showing tuberculosis.

The first follow-up visit at 3 months showed that the patient was without any symptoms of the disease, with local and general findings being unremarkable. No further anti-TB treatment was instituted. The most recent follow-up visit occurred in January 2011, using the all aforementioned diagnostic tools. In particular, chest CT showed excellent recovery (Fig. 4a and b). No signs or symptoms of the TB were noted and the patient was considered disease-free.

Discussion

Tuberculosis of the sternum and ribs is rare, representing 1–2 % of all musculoskeletal forms of the disease [1]. Having different pathophysiologic roots, it may resemble a pyogenic abscess or tumor mass. Surgery followed by postoperative drug (anti-TB) treatment can be used in this setting [2]. In our case, the surgical treatment included anterior chest wall resection with the removal of deep muscle, ribs, and sternum to achieve an appropriate safety margin. While resection of the thoracic wall with massive defect is generally followed with the high mortality, with current use of modern preoperative, operative, and drug treatment, it is feasible to perform these large operations with reasonable mortality [3].

In cases of a full-thickness chest wall defect, many rigid implants may be used [4]. Modern titanium devices are rigid, corrosion-free, chemically inert implants that are quickly and precisely adaptable to the shape of the thoracic wall. Moreover, titanium can safely be imaged with both CT and magnetic resonance imaging, and therefore it does not affect the follow-up. Traditionally, most of the available chest wall prosthesis materials are evolved from implanted

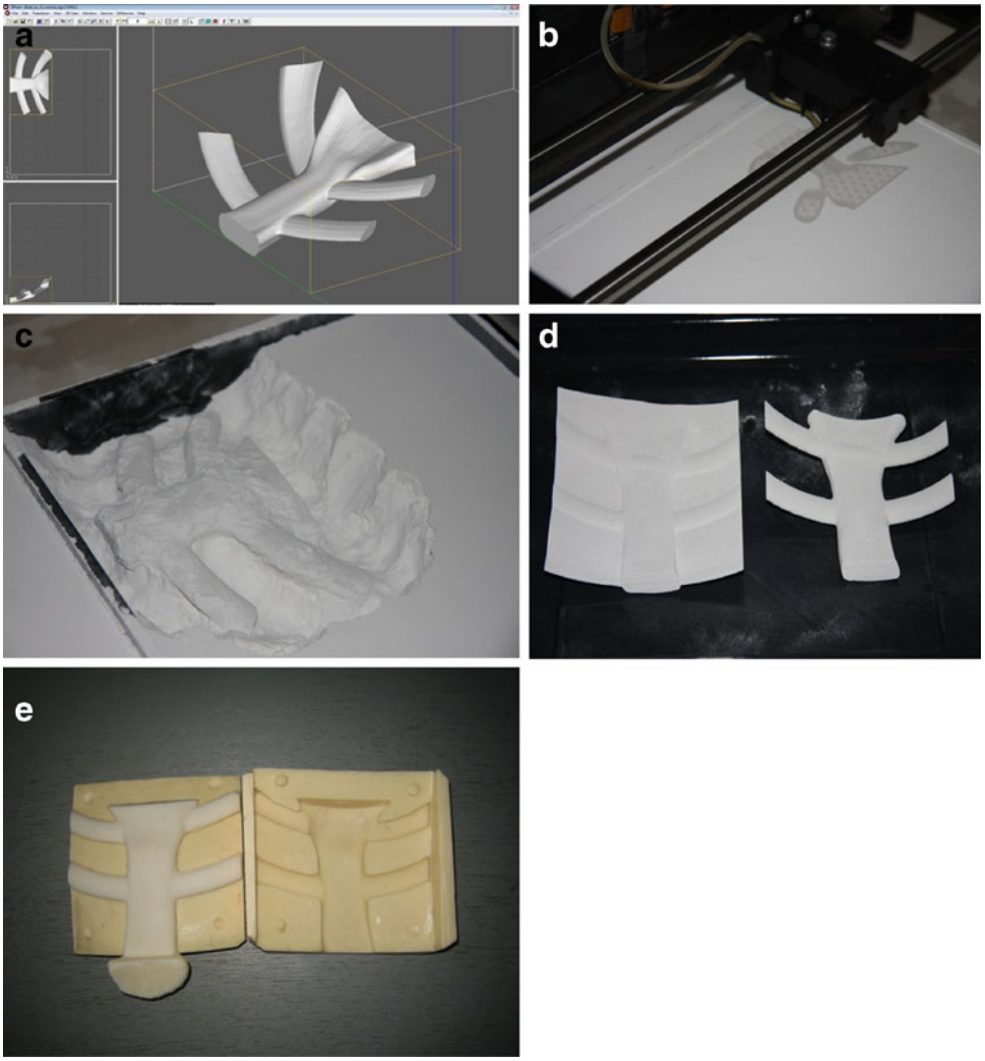

Fig. 2 **a** Digital making of sternal model, **b** printing of the sternal model, **c** molding of the early version of the module, and **d** and **e** molding of the final version of the module

devices used in other fields such as abdominal repair. A common feature of these materials is their biological "inertness," nonreactivity, and durability [4]. According to these principles, several meshes, such as Prolene and Marlex meshes, have gained acceptance [4]. However, the use of these materials may lead to an infection [4]. Chronic and persistent pain, erosion, bleeding, hematoma, and pulmonary restrictive disease may occur due to inadequate incorporation, mesh shrinkage, and migration. In such circumstances, most of the prostheses must be removed [5].

In cases of the sternal, chest wall, and diaphragm reconstruction, Composix Mesh™, titanium mesh, and Marlex mesh [6] as well as methyl methacrylate [7, 8] were also successfully used. Although resection of tumors in this region with sufficient margins may lead to large chest wall defects, primary closure of these defects can be satisfactorily achieved in most cases. As far as our knowledge is concerned, this seems to be the very first attempt to produce anatomical design of sternal defect. We believe that ideal prosthetic material characteristics should (a) be strong enough to withstand physiologic stresses over a long period; (b) conform to the chest wall; (c) promote strong host tissue ingrowth, which mimics normal tissue healing and ensuring wall incorporation; (d) resist erosions into surrounding tissue and visceral structures; (e) not induce allergic or adverse foreign body reactions; (f) resist infection; and (g) be easy to use. The material and the technique we have used seem to confirm our hypothesis. A follow-up done almost 2 years (exactly 22 months) after the surgery with CT scan confirms clinical observation about satisfaction in both functional and cosmetic outcomes. In addition, due to postoperative anti-TB drug treatment, the patient is free of any signs and symptoms of the disease. While we believe that 2-year follow-up in noncancer lesions may be sufficient, we continue to monitor the patient in regular intervals to achieve better perspective for the future use of this approach.

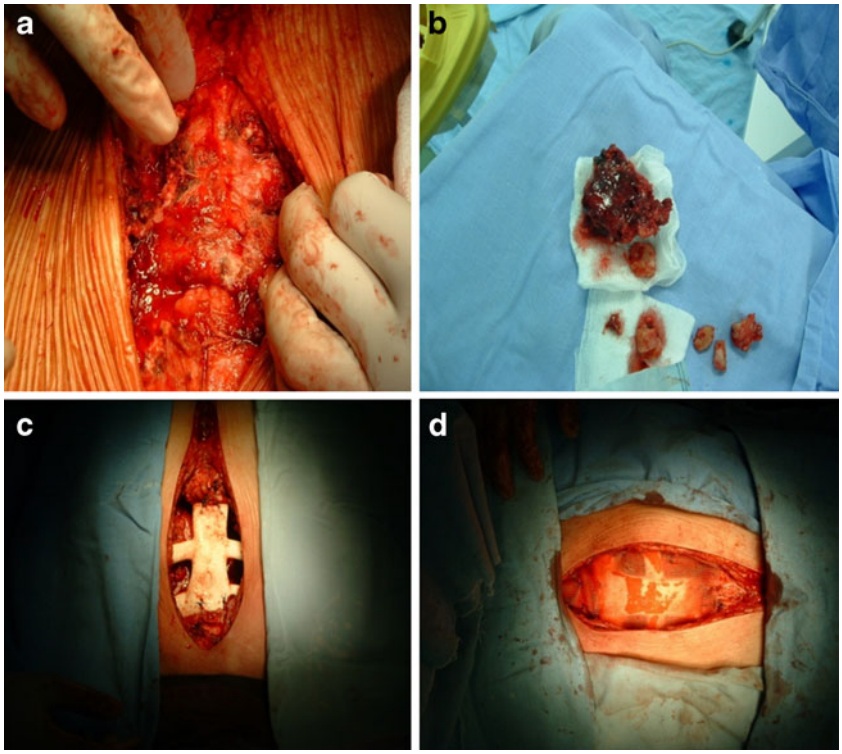

Fig. 3 **a** and **b** Intraoperative removal of the sternal infiltration and **c** and **d** implementation of the sternal module intraoperatively

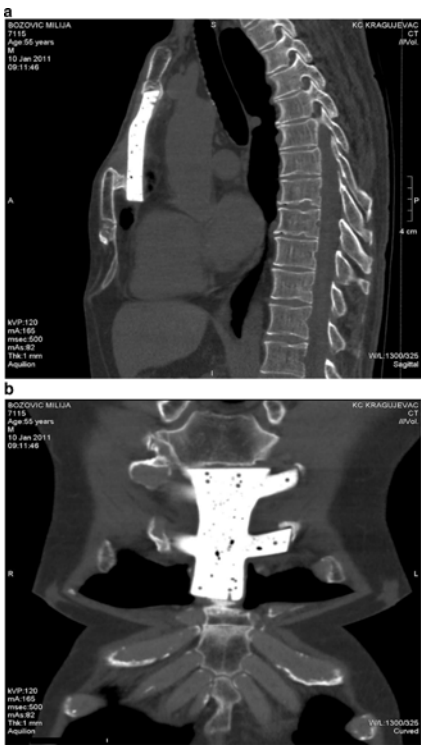

Fig. 4 **a** and **b** Control CT of the thorax 1 year after implementation (CT, computed tomography)

Disclosures None to report.

References

1. Tuli SM (2000) Tuberculosis of rare sites, girdle and flat bones. In: Tuli SM (ed) Tuberculosis of the skeletal system (bones, joints, spine and bursal sheaths), 2nd edn. Jaypee Brothers Medical Publishers Ltd, Delhi, pp 159–160
2. Cho KD, Cho DG, Jo MS (2006) Current surgical therapy for patients with tuberculous abscess of the chest wall. Ann Thorac Surg 81:1220–1226
3. Deschamps C, Tirnaksiz BM, Darbandi R et al (1999) Early and long-term results of prosthetic chest wall reconstruction. J Thorac Cardiovasc Surg 117:588–592
4. Weyant MJ, Bains MS, Venkatraman E et al (2006) Results of chest wall resection and reconstruction with and without rigid prosthesis. Ann Thorac Surg 81:279–285
5. Qin X, Tang H, Xu Z et al (2008) Chest wall reconstruction with two types of biodegradable polymer prostheses in dogs. Eur J Cardiothorac Surg 34:870–874
6. Hirai S, Nobuto H, Yokota K et al (2009) Surgical resection and reconstruction for primary malignant sternal tumor. Ann Thorac Cardiovasc Surg 15:182–185
7. Rathinam S, Venkateswaran R, Rajesh PB, Collins FJ (2004) Reconstruction of the chest wall and the diaphragm using the inverted Y Marlex methylmethacrylate sandwich flap. Eur J Cardiothorac Surg 26:197–201
8. Di Candia M, Wells FC, Malata CM (2010) Anterolateral thigh free flap for complex composite central chest wall defect reconstruction with extrathoracic microvascular anastomoses. Plast Reconstr Surg 126:1581–1588