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CASE REPORT

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Antibiotic-loaded ceramic sternum for sternal replacement in a patient with deep sternal wound infection

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Abstract

A 68-year-old man presented with destruction of his sternum after cardiac surgery. Classical management with multiple debridements, vacuum dressings and antibiotics failed. A replacement of his sternum was performed using an antibiotic-loaded porous alumina ceramic sternum. Despite the infected wound, the ceramic sternum did not get infected due to the high antibiotic concentration obtained locally. Two years after the surgery, no relapse occurred and the pulmonary function tests improved.

Keywords: Sternum • Deep sternal wound infection • Alumina • Antibiotic loaded • Mediastinitis • Pulmonary function tests

INTRODUCTION

To date, there is no surgical 'gold standard' for sternal replacement after sternum destruction as a result of deep sternal wound infection. In the search for new possibilities of reconstructing the sternum, a porous alumina sternal prosthesis was developed (I.Ceram®, Limoges, France) [1]. Its porous structure can be loaded with antibiotic, which allows a localized release and protection of the implanted device in an infected environment.

CASE REPORT

A 68-year-old man presented with a deep sternal wound infection with sternal dehiscence and partial destruction following coronary heart bypass. Despite multiple surgical debridements, vacuum-assisted closure and antibiotic therapy, wound did not heal and sternum was partially lysed. To replace the sternum, a 'protected' device was needed. A gentamicin-loaded (320 mg) ceramic sternum was implanted after 10 months of hospitalization (Fig. 1). Gentamicin targeted bacteria were found in the wound and bone (methicillin-resistant *Staphylococcus aureus*, methicillin-resistant *S. epidermidis* and *Klebsiella pneumoniae*). Local samples were obtained using a Redon drain. One hour after implantation, local gentamicin concentration was 1500 mg/l, and it was 395 mg/l after 24 h. At the same time, no gentamicin was detected in blood during the first 48 h. As gentamicin released acts as a prophylaxis, a systemic treatment was prescribed for 6 weeks. The wound healed quickly and the patient was discharged from hospital 3 weeks after surgery. Follow-up did not reveal complications. More than 2 years after this surgery, the patient did not relapse and the pulmonary function tests improved (Fig. 2).

COMMENT

Vacuum-assisted closure therapy is usually used during the early stages of healing and a muscle or omental flap is proposed thereafter [2, 3]. Pitfalls of the muscle flap technique are mostly residual pain, seroma, arm strength loss, chest wall instability and pulmonary function impairment [4]. Generally, no foreign body is used due to the risk of infection. In some cases like the one described here, classical therapy is not efficient and patients need sternectomy and reconstruction [5].

Porous alumina ceramic has previously proved its usefulness in sternum replacement, particularly in cases involving tumours [1].

The local antibiotic release offered by this type of ceramic, with high localized concentrations, allowed the protection of the device and completion of the debridement. The concentration for efficacy, which must be at least 8 times that of the Minimal Inhibitory Concentration (C_{max}/MIC > 8), was largely exceeded (>175 folds) after only 1 h and for at least 24 h (>50 folds), ensuring the eradication of bacteria. These active concentrations are of interest in an area where antibiotic diffusion is poor. These high local concentrations are non-toxic and previous studies have already reported better healing and wound closure with other loaded devices (e.g. collagen sponges and orthopaedic cement).

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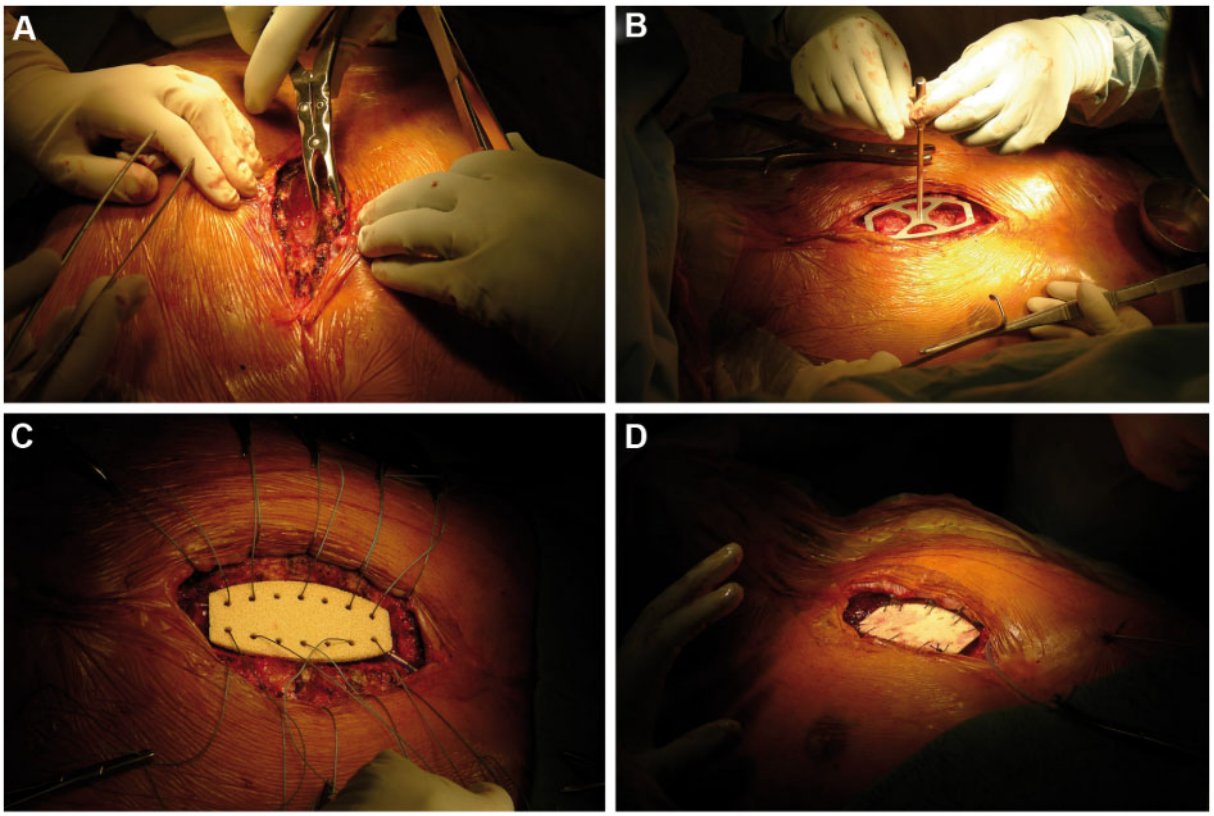

Figure 1: Surgery technique. (**A**) Debridement of the sternal area. (**B**) Use of the trial implant to choose the appropriate size and to remove parts which could impede implantation. (**C**) Prosthesis was then secured to the ribs by size 3 non-absorbable sutures threads using the pre-existing holes. (**D**) After anchoring.

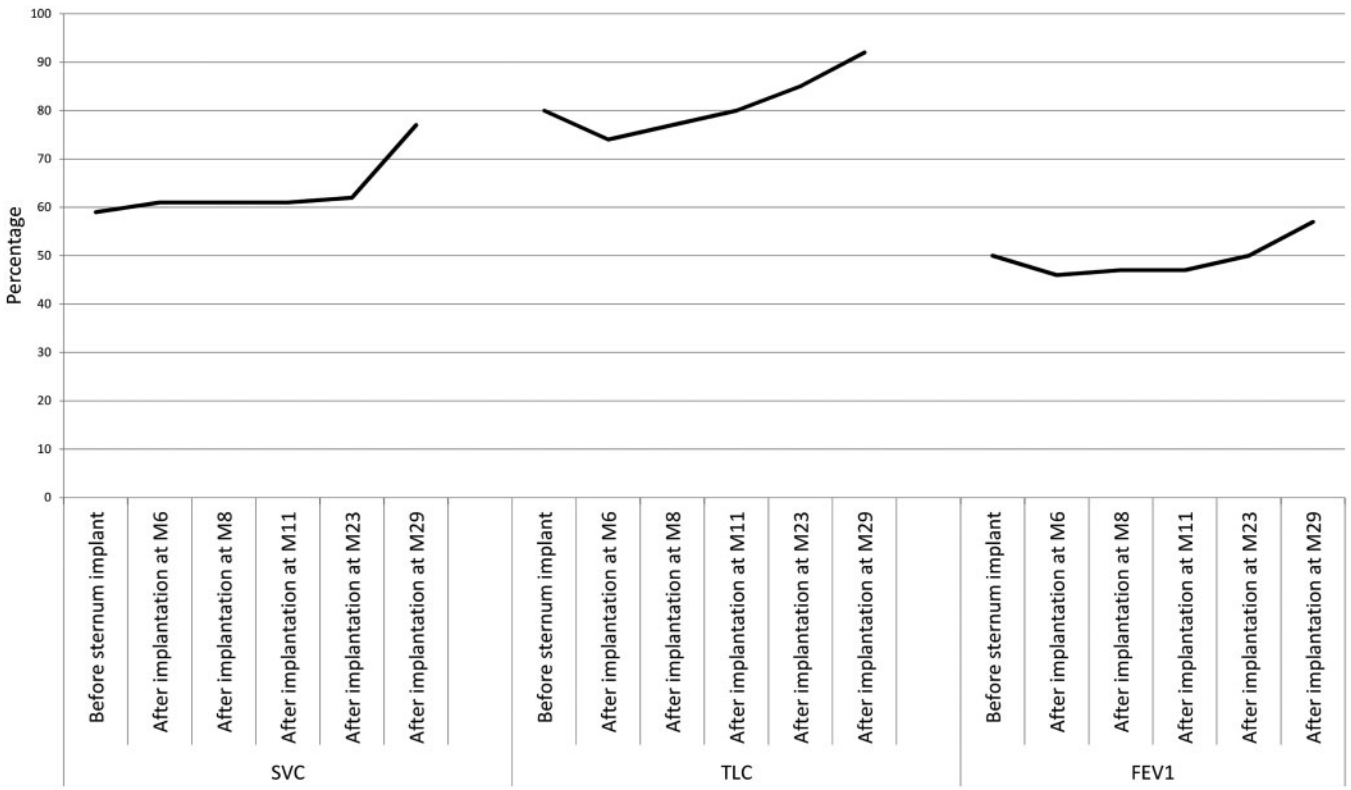

Figure 2: Evolution of three parameters of pulmonary function tests after sternum implantation. FEV_1: forced expiratory volume in 1 s; SVC: slow vital capacity; TLC: total lung capacity.

Video 1: Summary of the sternum replacement technique using a loaded ceramic sternum.

At the same time, non-detectability of gentamicin in the blood guarantees the absence of toxicity. To target other bacteria and extend the spectrum of efficacy, vancomycin can also be loaded alone or in combination with other antibiotics.

Even though the ceramic is rigid, the means of anchoring through non-resorbable suture threads allows reconstruction of the thoracic cage, protection of the underlying organs and an improvement in pulmonary function. The ceramic used is a porous alumina which is fully biocompatible and inert, ensuring its colonization by surrounding cells and good long-term tolerance.

The present case suggests that this antibiotic-loaded ceramic device combines the possibility of chest wall stabilization and its self-protection during implantation and is thus a new treatment option for this life-threatening condition or for patients at a high risk of postoperative infection during tumor surgery.

Conflict of interest: François Bertin is member of the scientific committee of I.Ceram®. Eric Denes is employed by I.Ceram®. Jeremy Tricard and Anaëlle Chermat have no conflict of interest to declare.

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