Institutional review - Thoracic general

An alternative inexpensive treatment for deep sternal wound infections after sternotomy

A. Lappa*, M.R. Malpieri, M. Cicco, A. Bucci, M. Malpieri, F. Araimo, D. Alampi

Hyperbaric Center, ICOT, V. F. Faggiana 34, Latina, Italy

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Abstract

We present three cases of deep sternal wound infections after sternotomy, with partial dehiscence and instability of sternum, successfully treated with combined therapy based on hyperbaric oxygen (HBO), parenteral and intranasal antibiotics, daily debridements and medications. After a short hospitalization (10 days) to detect involved bacteria, depth of the wounds and choice of right antibiotic therapy, all patients continued the treatment as outpatients, undergoing daily medications and antibiotic therapy before every HBO session. After 3 months the sternal wounds were completely epithelialized. This conservative therapy for deep sternal wound infections can be an alternative and inexpensive approach to surgical treatment. The aggressive surgical approach could be limited for those deep sternal wounds associated with broad dehiscence and instability of sternum, complicated by paradoxical breathing and/or mediastinitis and alteration of respiratory system mechanics.

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1. Introduction

Sternal wound infections, after median sternotomy, remain a potentially lethal complication and a serious cause of postoperative morbidity and mortality.

Their frequency is estimated to be between 2.5 and 12%.

The recommended treatment of sternal wound infections is aggressive and consists of meticulous debridement, wires removal, drainage, irrigation, open packing and dressing changes, followed by plastic reconstruction with rotational muscle flap [1–3].

Disadvantages are numerous: morbidity consequent to serial debrideaments, daily dressing changes and overall, the need of prolonged paralysis and mechanical ventilation to stabilize the sternal edges when wires removing is required.

The use of a vacuum assisted closure device can act as a sternal stabilizer until the resolution of local infection allows a regional muscle flap rotation or primary wound closure. But it can partially shorten the length of paralysis and mechanical ventilation [4,5].

Our report is relative to outpatients affected by deep sternal wound infections after median sternotomy with partial instability and dehiscence of sternum, without paradoxical movement and mediastinitis. They were successfully treated with conservative therapy based on hyperbaric oxygen, parenteral and intranasal antibiotics, local debridement and daily medications.

2. Methods and materials

2.1. Patient no. 1

Woman 62 years old, underwent sternotomy for malignant thymoma, after radium therapy showed a dehiscence, about 6 cm, in the upper part of sternum. Her sternal wound was deep, with slight granulation and purulent secretion (Fig. 1). During her recovery, before the beginning of hyperbaric oxygen (HBO) therapy, microbiological samples from the wound and nasal swabs were collected. She resulted a nasal carrier of...
Staphylococcus aureus and an oxacillin/methicillin resistant S. aureus was involved in the sternal wound too.

2.2. Patient no. 2

Man 72 years old, developed a deep sternal wound after sternotomy for threefold coronary artery bypass graft (CABG), harvesting a single internal mammary artery (IMA). He was affected by insulin dependent diabetes mellitus. His sternal dehiscence was about 5 cm large in its median part. He had already undergone surgical debridement with removal of two wires. Nasal colonization and sternal wound resulted positive for S. aureus, like the patient no. 1.

2.3. Patient no. 3

Man 57 years old, with insulin dependent diabetes mellitus, presented dehiscence of sternal wound, 1 month after double CABG, using a single IMA. Sternal culture revealed an oxacillin/methicillin resistant S. aureus infection. His nasal swabs were negative for S. aureus. His wound was about 4 cm long, in the upper part of the sternum and appeared deep, with yellow secretions and a slight tendency to granulate.

During their short hospitalization, all patients underwent 99mTc – HMPAO labelled leukocyte scan and it resulted positive in all cases [6]. Laboratory investigations showed: white blood cell upper 10,000 cells/mm³, elevation of the C – reactive protein (>0.1 mg/dl) and of erythrocyte sedimentation rate (about 100 mm/h).

In all the cultures from sternal wounds grew oxacillin/methicillin resistant S. aureus. Teicoplanin was chosen and administered at recommended dosage for osteomyelitis (800 mg qd for 3 days and followed by 400 mg qd) for 6 weeks at least.

The daily dose was administered intravenous immediately before the beginning of every daily hyperbaric session, to increase the post antibiotic effect (PAE) and post antibiotic leukocyte enhancement (PALE) of teicoplanin.

Two patients (nos. 1–2) with nasal colonization by S. aureus were treated with intranasal mupirocin (MPN), bid for the whole period of antibiotic therapy. In fact the usual postoperative treatment of 5 days, in case of sternal wound infection by S. aureus, appeared to be not sufficient [7].

The patients showed a nasal re-colonization by S. aureus, after a short period of negative swabs and because of this we decided to continue the treatment with MPN nasal application for the whole period of parenteral antibiotic therapy (for 6 weeks at least).

In diabetic patients insulin dosage was adjusted to maintain glycemia lower than 110 mg/dl as suggested by literature [8].

The patients were discharged after 10 days and continued their therapy as outpatients.

Hyperbaric treatment was standard and performed in a multiplace chamber. Each session was 90 min long. The phase of compression with air, lasted 10 min to reach 2.4 ATA (240 kPa of pressure), the equivalent of 14 m under sea. Then all patients breathed oxygen 100% for 60 min, through face mask well fitted and secured with head straps. After, the phase of decompression could begin.

HBO sessions were daily, from Monday to Friday, with break of 2 days to avoid toxics problems related to hyperoxia.

The medications were performed every day, with clorexidine soap, local debridement and cleaning of the wound. Later, when the bacteriological samples resulted negative and good granulation was achieved, collagen pads (ANTEMA, OPOCRIN SpA) was applied on closing sternal wound.

3. Results

A dramatic improvement was noted after 1 month of therapy. After thirty HBO sessions, wounds started gradually to close and the surgical approach could be excluded (Fig. 2).

![Fig. 1. The wound before the application of HBO therapy.](https://academic.oup.com/icvts/article-abstract/2/4/629/70753/14.04.2019)

![Fig. 2. The same wound after thirty HBO sessions.](https://academic.oup.com/icvts/article-abstract/2/4/629/70753/14.04.2019)
Fig. 3. After 60 HBO sessions, the same sternal wound was completely closed; it was possible to observe a slight hyperemia and brightness of skin.

After 40 HBO sessions the wounds were nearly closed, 3 months later (60 sessions), all sternal wounds were completely epithelialized (Fig. 3). The C reactive protein, ESR and WBC values were normalized. Scintigraphic labelled leukocyte scan was repeated and confirmed the complete resolution. No complication and side effect for HBO was observed.

Twelve months later, a follow up showed no recidivity.

4. Discussion

Deep sternal wound infections following sternotomy for cardiac and thoracic surgery are important causes of potentially lethal complications and added costs.

The risk factors linked with sternal wound infections are numerous and can be divided in two groups: host linked and surgery linked.

This last group includes the duration of surgery, postoperative bleeding, reoperation, rewiring, use of intraaortic balloon pump, but overall the use of bilateral IMA in CABG. These arteries provide the primary blood supply to the sternum. Its logical to think that significant ischemia, caused by harvesting two IMA, predisposes a devitalized environment where the infection can develop and flourish. Therefore, the use of bilateral IMA is not recommended, but because of the higher patency rate of IMA, if compared to the saphenous vein, the use of single IMA for CABG has become the standard treatment, when this is possible.

Host intrinsic risk factors are: increasing age, obesity, cigarette smoking, steroid therapy, but the major risk factors are identified in the nasal carriage of S. aureus and diabetes mellitus. In many cardiac surgical departments, nasal carriers of S. aureus are preoperatively detected by nasal swab and treated with MPN prophylaxis [9]. The usual schedule is an intranasal application of MPN on the evening before and on the morning of heart surgery and bid for 5 days.

Our two patients (nos. 1-2) were not detected as nasal carriers of S. aureus and did not received MPN prophylaxis and all of them had some risk factors.

The preferred treatment of deep sternal wounds is surgical but we decided for a conservative approach, because our patients showed a partial dehiscence and instability, with absence of paradoxical movement of the sternum and without involving respiratory system. HBO therapy is the principle basis of this treatment. It catalyzes all reparative phenomena and enhances antibiotic efficacy.

HBO therapy permits to achieve high levels of oxygen in the arterial blood and in tissues, with consequent biochemical cellular effects. In fact the neutrophil mediated killing of bacteria by free radicals is increased and because of high amount of free radicals HBO also exhibits a direct antibacterial activity against anaerobes. Then post antibiotic effect is prolonged (defined PAE: post antibiotic effect) and leukocyte action is further increased (called PALE: post antibiotic leukocyte enhancement) [10-12].

Therefore daily antibiotic dose was administered immediately before the beginning of every HBO session.

When serial cultures resulted sterile, the wounds showed a clean granulation and a reduction of depth, we decided for local application of collagen pads.

This product contains collagen type I, deriving from equine Achilles tendon. Collagen type I, as collagen type III is less immunogenic than type II, because of low rate of glycosidic groups and aromatic amino acids as tyrosine and tryptophan.

The method of extraction and purification make this product microbiological and immunological safe.

Heterologous collagen enhances the action of homologous collagen, increasing platelets aggregation and their subsequent release of growth cellular factors.

The reparative effect is based on three phenomena: fibroblast migration towards collagene reticulum, synthesis of new homologous collagen matrix and keratonocyte proliferation performing desmosomes with collagenic reticulum. Angiogenesis and granulation are also stimulated [13].

Usually the healing of wounds with important loss of substance occurs by ‘second intention’ with the replacement of anatomical tissue by fibrous tissue.

When HBO therapy is applied, the result is ‘restitutio ad integrum’. There is not cicatricial tissue.

To our knowledge, these are the first reported cases of deep sternal wounds precociously treated with HBO, associated with antibiotics (intravenous and intranasal when required) and daily medications in outpatients.

In literature, it is reported on a patient who developed infective deep sternal wound, 2 months following heart transplantation [14].

Open wound therapy, with wires removal, daily medications and debridement was applied with poor result. After 4 months, because of slight tendency to granulate of
the wound, the patient began HBO therapy. The decision was late.

It is evident that HBO therapy associated with targeted antibiotics is useful for all infective wounds, above all with poor granulation, not only by *S. aureus*.

Hyperbaric oxygen enhances antibiotic effect, blocks infective process and accelerates all restorative phenomena. This conservative and combined therapy can be an alternative approach, when this is possible, offering many advantages if compared with surgical treatment: safety, less complications and low expenses for shorter hospitalization than the prolonged recovery required by surgical treatment. The aggressive surgical approach could be limited for those deep sternal wounds associated with broad dehiscence of sternum and paradoxical movement impairing respiratory system mechanics. In fact physiological movements of rib cage can be affected and inspired air volume can be reduced. For these cases, surgical approach and mechanical ventilation to stabilize sternal edges remain the first therapeutic choice. Undoubtedly other studies could be conducted to better evaluate therapeutic benefits of this treatment.

**References**


**Appendix A. ICVTS on-line discussion**

**Author:** Mr. Andrew Mair, Research Fellow, Royal Group of Hospitals Trust, Department of Cardiac Surgery, Royal Victoria Hospital, Grosvenor Road, Belfast BT12 6BA, UK.

**Date:** 10-Oct-2003

**Message:** I would like to congratulate the authors for their successful use of a novel therapeutic method to treat a difficult patient problem. They have shown that despite their patients having strong risk factors for poor sternal healing (post-radiotherapy, mammary artery use in the diabetic patient), a positive outcome is possible without major further surgical intervention.

In their paper, the authors describe this treatment modality as "an alternative and inexpensive approach" to the problem of sternal dehiscence. Whilst I agree that this is a valid alternative, the authors do not reveal any details of costs for their hyperbaric therapy. Each patient had 60 sessions, which will have taken 12 weeks to complete, each of 90 minutes. They were also seen daily for cleaning and debridement of their wound followed by redressing. This approach will necessitate the involvement of a range of differing nursing, medical and technical staff. It seems unlikely that outpatient therapy would cost more than inpatient treatment, but the authors have not detailed the costs involved, making comparisons difficult.

It would be interesting to compare these three patients with a control group who have not received hyperbaric oxygen. I also wonder if patients with obstructive airways disease could tolerate such high concentrations of oxygen.