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When surgical option is not provided: a successful multidisciplinary approach to a refractory case of sternal osteomyelitis following coronary surgery

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Abstract

Purpose Sternal osteomyelitis is a major complication of cardiac operations performed through median sternotomy. The surgical treatment, which involves the debridement and removal of whole infected and necrotic tissue is the standard of care, although it is sometimes unachievable. This may occur, for instance, when the infectious-inflammatory process invades the anterior mediastinum and tenaciously incorporates one or more of vital anatomical structures.

Methods and results An inoperable case of postoperative sternal osteomyelitis that involved the right ventricle and the right coronary artery, and that was successfully treated using a nonsurgical multidisciplinary approach, is reported here.

Conclusion For highly selected patients with sternal osteomyelitis for whom surgery is a too risky option, an approach including the contribution of various specialists might be a viable way out.

Keywords Dalbavancin · Hyperbaric oxygen therapy · ITA harvesting · Labeled leukocyte scintigraphy · Sternal osteomyelitis

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Introduction

Sternal osteomyelitis (SO) is a major complication of cardiac surgery that occurs in up to 4% of operations through median sternotomy [1–3]. It usually derives from the worsening and progression of a more superficial sternal wound infection and, when not promptly recognized and effectively treated, can be complicated by anterior mediastinitis; actually, SO can be sometimes combined with mediastinitis from inception. In the presence of mediastinitis, mortality ranges between 10 and 25% [1–4]. However, the occurrence of SO may be associated with high morbidity and prolonged in-hospital stay even in the absence of mediastinitis. A range of risk factors, including diabetes mellitus, morbid obesity, chronic obstructive pulmonary disease, and the internal thoracic artery (ITA) harvesting, has been identified [1–3]. Several pathophysiological mechanisms have been proposed [5, 6]. Unfortunately, the diagnosis of SO is not always immediate, and the surgical treatment can be very challenging and risky option [7–9]. This fact occurs when the infectious-inflammatory process extends beyond the posterior sternal periosteum, invades the soft tissues of the anterior mediastinum, and tenaciously incorporates one or more of vital

anatomical structures. Furthermore, infection may relapse in a significant number of patients despite appropriate antibiotic therapy, surgical debridement, and removal of whole infected and necrotic tissue.

An inoperable case of SO following coronary surgery that was successfully treated using a nonsurgical multidisciplinary approach is reported here.

Case report

In June 2020, a 57-year-old man with post-infarct angina and three-vessel coronary artery disease underwent low-risk (1.8% by the European System for Cardiac Operative Risk Evaluation II) coronary surgery using both ITAs at the Division of Cardiac Surgery of the University Hospital of Trieste, Italy. Moderate pectus excavatum (Haller index, 3.2), hepatitis C virus chronic infection and cirrhosis combined with cryoglobulinemic vasculitis, peripheral vascular disease requiring multiple interventions, and a history of frequent gastrointestinal bleeding due to peptic disease and intestinal polyposis were major co-morbidities. Immediate postoperative course was uneventful and, on postoperative day one, the patient was discharged from the intensive care unit to the inpatient ward, where a deep cutaneous eschar with underlying hematoma formed along the lower half of the full sternotomy. The sternal wound was re-sutured, and the sternal bone was re-wired. Following labeled leukocytes scintigraphy showing infection limited to presternal soft tissues and not involving the sternal bone (Fig. 1a), the patient was discharged home. However, about 4 months from the original operation and 10 days from hospital discharge, he developed a sternal dehiscence with infection. New scintigraphy imaging (Fig. 1b, c) and chest computed tomography scanning (Fig. 2) showed, respectively, sternal bone infection and the presence of tenacious adhesions involving the anterior wall of the right ventricle (including the right coronary artery). Following multidisciplinary evaluation (Fig. 3), a nonsurgical approach, which included hyperbaric oxygen therapy (HOT; Fig. 4) and antibiotic regimen including dalbavancin administration (two rounds for both) was

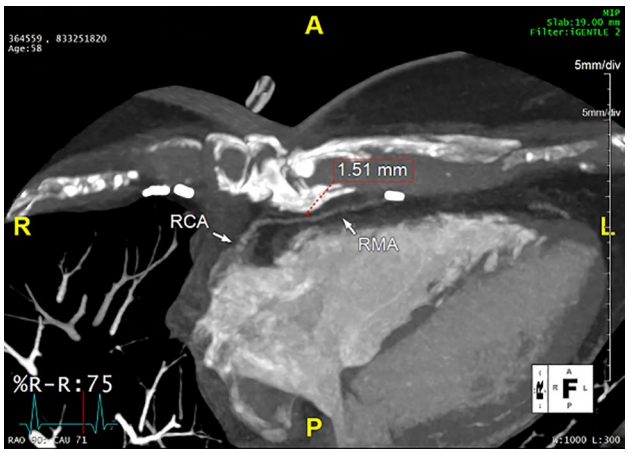

Fig. 2 Chest computed tomography scan showing complete adhesion between the RV anterior wall (including the RCA and the RMA) and the infected sternal bone. *RCA* right coronary artery, *RMA* right (acute) marginal artery, *RV* right ventricle/ventricular

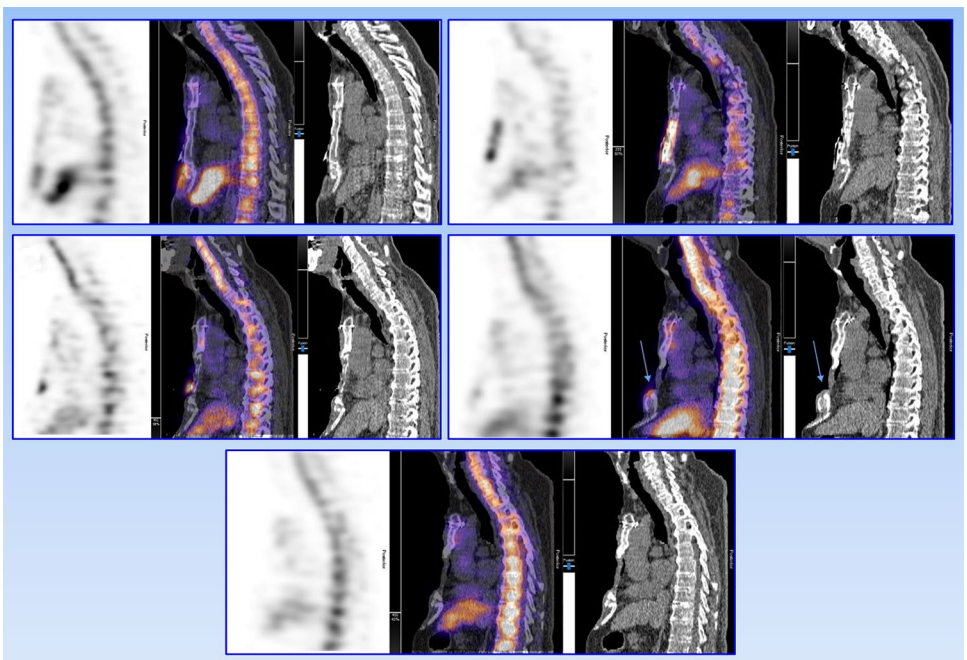

Fig. 1 **a**–**e** Labeled leukocyte scintigraphy imaging: **a** pre-xiphoid soft tissues infection not involving the sternal bone; **b** osteomyelitis of the caudal half of the sternum (right side) in continuity with pre-xiphoid soft tissues infection; **c** mild focus of sternal osteomyelitis; **d** minimal focus of sternal osteomyelitis (arrow); **e** no evidence of sternal wound infection.

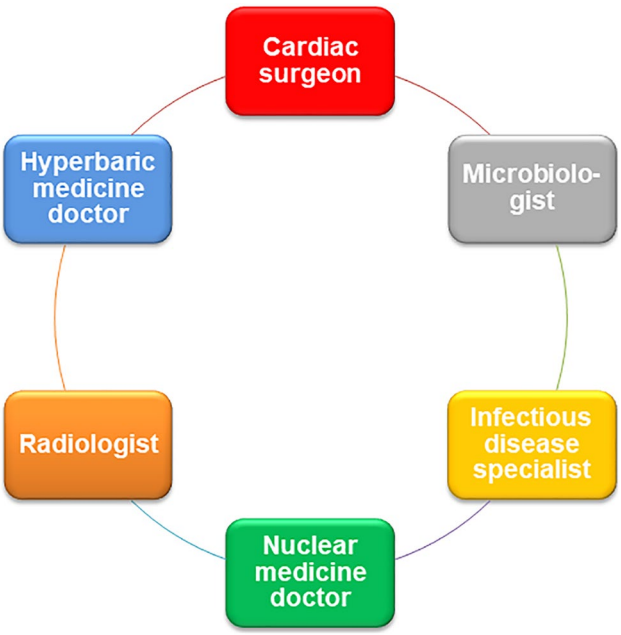

Fig. 3 Multidisciplinary approach

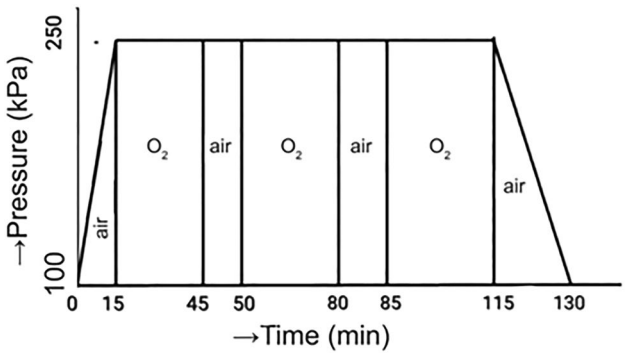

Fig. 4 HOT. As the patient's peri-lesional transcutaneous O_2 level was within the therapeutic range (50–90 mmHg at sea level, i.e., 1 ATA, while breathing air) and increased well following 100% normobaric O_2 administration, there was indication to HOT, which involved 100% O_2 inhalation at a pressure exceeding 1 ATA (=101.3 kPa) to enhance the amount of O_2 dissolved in the body tissues. The patient underwent HOT, in a multiplace chamber, once a day for five times at week. Each HOT session lasted 130 min and included seven phases: compression, 100% O_2 inhalation at a pressure of 2.5 ATA (3 times), ambient air break (2 times), and decompression. Overall, the patient underwent 24 sessions (2 cycles). All sessions were well tolerated by the patient. *ATA* atmosphere absolute, *HOT* hyperbaric oxygen therapy, *O_2* oxygen, *KPa* kilopascal

chosen. After 689 days from inception of sternal wound dehiscence, there was remission of the disease (Fig. 1d, e) and, after 987 days, the patient's healing (Fig. 5).

Discussion

Surgical treatment of SO involves the thorough debridement of the involved structures behind the sternum, the complete excision of the infected necrotic bone (sequestrum), a variable length time period of negative pressure wound therapy, and, finally, the reconstruction step using a muscle flap. To eradicate the infection, a complete sternectomy has to be sometimes performed instead of a piecemeal sternal resection [9]. In very rare cases, however, no complete surgery is possible due to the infective-inflammatory process that harness tenaciously some vital mediastinal structures, such as the native or prosthetic great arteries, the right ventricle, the coronary arteries and any patent coronary grafts. In these cases, a nonsurgical therapy is required.

There would be several interesting aspects in this case report, at least in the present authors' opinion. First, in a patient with pectus excavatum, a refractory case of SO following bilateral ITA grafting was successfully treated using neither retrosternal debridement nor complete excision of the sternal sequestrum. Second, a complex polymicrobial etiology was shown. Various bacteria were indeed identified in the sternal wound along the time. There were bacteria that are rare pathogens in humans, such as *Stenotrophomonas maltophilia* and *Staphylococcus lugdunensis,* bacteria that are particularly destroying for human tissues, such as *Stenotrophomonas maltophilia*, *Staphylococcus lugdunensis*, *Staphylococcus aureus*, *Klebsiella aerogenes* and *Bacteroides* spp*,* and bacteria that can develop antibiotic resistance, such as *Staphylococcus aureus, Staphylococcus epidermidis* and *Enterococcus faecalis* (Table 1). In addition, following the above-reported polymicrobial etiology and antibiotic resistances, various antibiotic protocols have been adopted along the time (almost 3 years). Of interest, in this report, dalbavancin was used in two different time periods 10 months apart. Dalbavancin is a second-generation lipoglycopeptide long-acting antibiotic that had been approved for acute bacterial skin infections. Over the years, however, it has gradually acquired a role as off-label treatment for osteomyelitis, spondylodiscitis, and septic arthritis caused by Gram-positive bacteria, primarily *Staphylococci*. As to concerns the present report, dalbavancin has been administered as two intravenous doses (1,000 mg and 500 mg, respectively) 1 week apart [10]. Last but not least, two cycles (24 sessions) of HOT were used 10 months apart to treat the patient of this report. In the literature, there is a growing body of evidence suggesting that sternal ischemia may play a significant role in the initiation of wound infection, and that this fact may be exacerbated by harvesting of one or both ITAs [1–3, 5]. Based on this concept, wound therapies involving negative

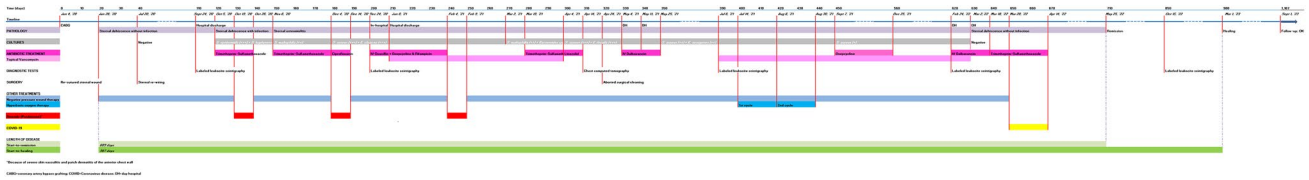

Fig. 5 Timeline

Table 1 Development of antibiotic-resistance in involved pathogens

Pathogen	Antibiotic	MIC (μg/mL)
Staphylococcus aureus	Clindamycin	0.12
	Doxycycline	2
	Erythromycin	4
	Rifampicin	4
Staphylococcus epidermidis	Clindamycin	1
	Erythromycin	4
	Gentamicin	4
	Levofloxacin	4
	Sulfamethoxazole + trimethoprim	4
Enterobacter cloacae	Amoxicillin + clavulanic acid	12

MIC minimal inhibitory concentration

pressure use have proven safe and effective for treatment of sternal complications [1]. Furthermore, HOT, i.e., the administration of 100% oxygen at pressures greater than atmospheric pressure, is widely used today to treat various wounds that are refractory to conventional therapies. Although the underlying mechanism is still being elucidated, there is a growing body of clinical evidence that supports this use. Recently, it has been suggested that there may be a role for HOT even in the treatment of sternal infection [6]. The theoretical mechanisms would seem plausible. Yet, there is only limited evidence to support its use at the present, though this report would seem increase it.

The present authors are persuaded that the use of dalbavancina in addition to every other antibiotic treatment, negative pressure wound therapy and HOT, all together made the patient recover without causing him to run unnecessary risks. Of course, there could be other, maybe more appropriate, methods of treatment, which would have reduced the treatment time, hospital stay and thus the suffering of the patient. To give an example, wound debridement and using negative pressure wound therapy could have completed the treatment earlier. Furthermore, it could reasonably be speculated that there would be complete wound healing even when only outpatient clinic open wound treatment had been carried out. In fact, the wound debridement (surgical cleaning) was tried after 320 days from original cardiac operation but aborted because of prohibitive risk for the patient. Negative pressure wound therapy was adopted from early inception of sternal dehiscence and continued almost uninterruptedly throughout the course of the disease. The treatment of the patient's infectious disease took place mainly in the outpatient clinic or during day hospital, except for the first intravenous antibiotic administration and the attempted surgical cleaning, which were both in-hospital performed.

In conclusion, this case report shows that, for highly selected patients with SO for whom surgery is a too risky option, an approach including the contribution of various specialists might be a viable way out. In common clinical practice, the management of often refractory infections such as osteomyelitis frequently involves several specialists. However, in this specific case, the multidisciplinary approach was crucial for the positive outcome. Given polymicrobial etiology of disease and antibiotic resistances developed, it was of paramount importance the contribution of microbiologist and infectious disease specialist who found, from time to time, the optimal antibiotic therapy to combine with HOT. Radiologist was also of utmost importance to confirm conclusively the prohibitive risk of complete sternal debridement and resection. Finally, medicine nuclear doctor showed any disease changes following each treatment.

Author contributions All authors whose names appear on the submission: 1. made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data; or the creation of new software used in the work; 2. drafted the work or revised it critically for important intellectual content; 3. approved the version to be published; and 4. agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Availability of data and materials Not applicable.

Declarations

Competing interests The authors declare no competing interests.

Ethical approval Internal Review Board of Azienda Sanitaria Universitaria Giuliano-Isontina (ASUGI) approved publication of the present case report. The patient gave full written consent to publish, in anonymous format, all clinical data concerning the present report.

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