

# Long-term result of bilateral pectoralis major muscle advancement flap in median sternotomy wound infections

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**Abstract. – OBJECTIVE:** Deep sternal wound infection (DSWI) is an uncommon but serious complication of open heart surgery being characterized by a high mortality rate and a considerable economic weight. Repair of sternal defects, compromised with infection, can be achieved in several ways. The aim of our study is to report our case load in the management of sternal wound infection.

**PATIENTS AND METHODS:** In this study, we will report our twelve-year case load with bilateral pectoralis major advancement flap as the sole treatment modality for deep sternal wound infection.

**RESULTS:** This surgical approach has given excellent results in terms of resolution of the infection of the sternum, with few complications and a good cosmetic result.

**CONCLUSIONS:** We propose bilateral pectoralis major advancement flap as the first choice treatment for deep sternal wound infection.

## Key Words:

Sternal infection, Sternal osteomyelitis, Pectoralis major muscle flap.

exploration for bleeding, and respiratory failure)<sup>10</sup>.

Repair of sternal defects, compromised with infection, can be achieved in several ways: primary wound closure in combination with irrigation<sup>11</sup>; local negative pressure therapy (VAC)<sup>12</sup>; VAC-therapy followed by definitive wound closure or sternal refixation using sternal plating<sup>13</sup>; primary or delayed flap closure by the use of regional myocutaneous flaps (myoplasty), such as the *pectoralis major* flap<sup>14-18</sup>, the *rectus abdominis* flap<sup>19</sup> and the *latissimus dorsi* flap<sup>20</sup>; or by the transposition of the greater omentum, with or without split-skin grafting<sup>9,21-24</sup>.

Treatment of DSWI often involves prolonged hospitalization, lengthy intravenous antibiotic therapy, additional operative procedures, and high costs. Therefore, it is important to evaluate the patient preoperatively to decrease the risk of complications and know how to treat this disease in the best way possible.

In this study, we will report our case load with bilateral *pectoralis major* advancement flap as the sole treatment modality for DSWI.

## Introduction

Deep sternal wound infection (DSWI) is an uncommon but serious complication of open heart surgery. Postoperative wound complications after cardiac surgery are still one of the major causes of morbidity and mortality. The reported prevalence of DSWI ranges from 0.7%<sup>1,2</sup> to 2.3%<sup>3-7</sup>.

Mortality rates reported from 0.5 to 9.1 percent for superficial sternal wound infections and 1.0 to 36 percent for deep sternal wound infections<sup>5,7-9</sup>.

The risk factors for DSWI could be divided into two groups: patient related (diabetes mellitus, obesity, prior myocardial infarction, chronic obstructive pulmonary disease, and aortic calcification) and procedure related (combined valve/coronary artery bypass graft procedures, aortic surgery, cardiopulmonary bypass -time, re-

## Patients and Methods

A retrospective chart review was performed from March of 2001 to July of 2013 on all patients referred to a single plastic surgeon for treatment of a deep sternal wound infection following median sternotomy for cardiovascular surgery at "Policlinico Umberto I", Rome, Italy. All patients with this complication were treated by the same protocol. There were a total of 73 patients with DSWI in this study.

At the time of treatment, the patients' ages averaged 67.7 years (range 45 to 82 years), and 60.4% (44) were men. 45 patients (61.6%) had originally undergone median sternotomy for either coronary artery bypass procedures, 10 pa-

tients (13.7%) for cardiac valve replacement and 18 patients (24.6%) for combined procedures. The mean BMI of the patients was 29.1 kg/m<sup>2</sup>.

The records of patients and the comorbidities, such chronic obstructive pulmonary disease, long duration of cardiothoracic surgery, diabetes mellitus, hypertension, hyperlipidaemia, chronic renal insufficiency and smoking, were collected from the medical records (Table I).

## Surgical Technique

Preoperative treatment of wound infections was negative wound pressure therapy (V.A.C. ATS Therapy System, KCI Concepts, Inc, San Antonio, TX) in 12 patients, while the remaining 61 patients underwent daily medications.

The surgical coverage proposed by us aims to create a multi-layer muscle barrier by advancing bilateral and contralateral major pectoral muscles performed in a single operative time after open heart surgery involving sternotomy. Of course, in patients with sternal osteomyelitis surgical times will be two at the same time, the first will be demolitive and then will run the reconstructive approach.

Demolitive approach involves the review of margins of previous surgical wound and infected and non-viable soft tissue. It continues with a copious irrigation of the wound with the solution containing hydrogen peroxide and normal saline. Bone debridement is undertaken to remove all non viable bone and staples with possible sequestrec-

tomy, sternectomy and a partial costectomy. The end point of bony debridement is marked by the appearance of bleeding in the cortical bone.

The *pectoralis major* flap was harvested through the midline sternotomy incision extended 5 cm inferiorly. A plane was developed between the pectoralis and the subcutaneous tissue bilaterally to the mid nipple line. Both pectoralis muscles were sharply elevated from their costal and sternal insertions, continuing the dissection in a subpectoral plane to allow bilateral advancement to the midline without tension (Figure 1). The humeral attachments of the pectoralis muscles were left intact and the thoracoacromial arteries were carefully preserved. The insertion of the pectoralis muscles was released with preservation of the long thoracic artery to aid in a tension-free closure. The pectoralis muscles were imbricated medially. A two-layer closure of the subcutaneous tissue and skin complete the procedure. Two or three drains were used and a broad-spectrum antibiotic coverage was carried out in the first 72 hours, and a specific antibiotic therapy based on the examination culture for at least six weeks. After the operation, the wounds were taped with sterile nonwoven tape to support the suture. Patients were positioned in a relaxed semiseated posture.

The advantages of our method are: the contraction of the major pectoral muscles, inserted on the contralateral portion of the sternum, favors matching of bone segments, the rich and constantly blood flow made from muscle tissue, which carries antibiotic therapy and improves the chance to eradicate the infection, the creation of a multilayer barrier that separates the residual bone portion from the skin colonized by pathogenic bacteria. It is also not altered respiratory function and is not interrupted the continuity of the abdominal musculature that is guilty of several local complications.

## Results

Microbiological testing of wound secretions revealed coagulase-negative *Staphylococcus* in 51.8% patients, *Staphylococcus aureus* positive in 25.9% patients, and 15.3% were negative. The remaining 7% of patients were positive for *Pseudomonas aeruginosa*, *Serratia marcescens*, *meticillin-resistant Staphylococcus aureus*, or *Enterococcus faecalis*.

The average hospital stay was 18 days, in 5 cases it was necessary to ICU. In 4 patients, there were hematomas resolved with drainage. 1 sero-

**Table I.** Patients and methods.

<i>Preoperative characteristics</i>	
Male-Female Ratio	44:29
Age (years): average and range	67,7 [45-82]
BMI (kg/m <sup>2</sup> )	29.1 [23.9-37.6]
Hypertension	40 (54.8%)
Hyperlipidaemia	35 (47.9%)
Diabetes mellitus	26 (35.6%)
Chronic obstructive pulmonary disease	8 (10.9%)
Chronic renal insufficiency	17 (23.2%)
Smoking	43 (58.9%)
<i>Surgical procedure:</i>	
CABG	45 (61.6%)
VALVE	10 (13.7%)
CABG + VALVE	18 (24.6%)

The digits in the parentheses showed the haplotype frequency in different groups.

**Figure 1.** Bilateral pectoralis muscle flap elevated from their costal and sternal insertions.



ma, 1 partial wound dehiscence. Only one patient with mediastinitis died in tenth postoperative day for heart failure.

In all other patients, we have solved the deep sternal infection, with normalization of clinical symptoms and laboratory parameters.

The follow-up ranging from 6 to 52 months, it will be a marked leukocytes scintigraphy at 3 months of surgery and laboratory tests (ESR, CRP and white blood cell count) at 1, 3, 6, 12 months postoperative.

## Discussion

Surgical site infections (SSIs) are the most common nosocomial infection in surgical patients and wound site infections are a major cause of postoperative illness, accounting for approximately one in four of all nosocomial infections<sup>25</sup>. An estimated 40-60% of these infections are thought to be preventable<sup>26</sup>. Post sternotomy deep sternal wound infection (DSWI) is a severe complication of open cardiac surgery which contributes significantly to patient morbidity and mortality and overall cost to the healthcare system.

The frequency of this complication varies globally partly due to definitions used; however, some centres have reported rates between 0.2% and 8%<sup>27</sup> and others ranging between 0.25% and 4%<sup>28</sup> of cardiac surgeries. The pathogenesis of DSWI involves a complex multifactorial process and includes a number of varying microbiological organisms. The most common pathogens reported

however continue to be *Staphylococcus epidermidis* and *Staphylococcus aureus* which comprise part of the normal commensal flora of the skin<sup>29,30</sup>. *Staphylococcus epidermidis* has been reported in recent times to be responsible for 43-64% of all DSWIs and of this number as many as 75% have been found to be methicillin resistant.

Several risk factors both patient and procedural dependent have been identified for DSWI. Pre-operative or patient factors include diabetes mellitus, obesity, smoking, COPD, low LVEF (left ventricular ejection fraction) and renal failure, etc. Intraoperative factors such as length of surgery and the use of bilateral internal mammary artery conduits have been considered important to the development of DSWI. Furthermore prolonged ventilation, redo-operation, requirement of transfusion and prolonged use of inotropic drugs as post operative factors in some studies have also shown association with DSWI.

Repair of sternal defects, compromised with infection, can be achieved in several ways: primary wound closure in combination with irrigation<sup>10,31</sup>; local negative pressure therapy (VAC)<sup>11</sup>; VAC-therapy followed by definitive wound closure or sternal refixation using sternal plating<sup>12</sup>; primary or delayed flap closure by the use of regional myocutaneous flaps (myoplasty), such as the pectoralis major flap<sup>13-17</sup>, the *rectus abdominis* flap<sup>18</sup> and the *latissimus dorsi* flap<sup>19</sup>; or by the transposition of the greater omentum, with or without split-skin grafting<sup>20,21</sup>.

In the past quarter century, well-vascularized flaps have been shown to provide stable coverage

to the sternotomy wound after radical debridement. In 1976, Lee et al<sup>21</sup> was the first to use an omental flap for closure of this deficit. In 1980, Jurkiewicz et al<sup>32</sup> reported the use of pectoral muscle flaps. These treatment strategies have increased long-term success from 50 percent<sup>33</sup>, to now 90 to 99 percent<sup>34,35</sup>. The average length of hospital stay has dropped from 84 days to under 13 days<sup>36</sup>. Vacuum assisted closure therapy combined with systemic antibiotics is used immediately upon any sign of significant wound infection – superficial versus deep possibly not yet clearly apparent<sup>37</sup>. This may alter the progressive course of the infective process by very early removal of infective material, stabilising any initial sternal instability and reducing dead space. Sternal dehiscence once manifested is then managed with surgical debridement.

Although the sternum is normally lacking muscular coverage, in treating an infected sternum, the use of muscle flaps has substantially reduced both hospital stay and mortality from this difficult problem. In addition, the muscle provides structural protection to the vital structures beneath following massive sternal debridement. *Pectoralis major* and *rectus abdominis* have become first-line flaps<sup>38</sup>, with the pectoral favored between the two<sup>9,23,39,40</sup>. Omentum flap is a second-line treatment choice even if some authors report good results, especially when it is transferred in the deep mediastinal<sup>9,23,24,31</sup>.

A major limitation of the *pectoralis major* flap has been coverage of the inferior third of the sternotomy wound<sup>41-43</sup>. It is the most common site for dehiscence after flap repair<sup>44,45</sup>.

DSWI is also an important economic factor for the hospital and health-care systems. In median, the costs for DSWI patients were almost 3 times as high as the costs of noninfected patients. A total of 9154 Euro were lost for every single case of DSWI during the study period. The main proportion of costs in DSWI case patients was among ward care, costs for additional surgical procedures and costs for prolonged intensive care unit (ICU). One may, therefore, assume that infection control measures for the reduction of DSWI will likely become cost-effective<sup>46</sup>.

## Conclusions

Deep sternal wound infection (DSWI) is an uncommon but serious complication of open heart surgery being characterized by a high mortality

rate, by a considerable economic weight for the hospital and finally cause additional suffering for the patient already suffering from a serious heart condition. Careful preoperative assessment of the patient is therefore essential with particular attention to the associations of risk factors. In the end, the surgical approach proposed by us has given excellent results in terms of resolution of the outbreak of the sternum, with few complications and a good cosmetic result. The early and aggressive approach results in decreased mortality, reduction of comorbidity with reduction in hospitalization times and, therefore, costs for the hospital.

## Conflict of interest

The Authors declare that there are no conflicts of interest.

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