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Original Article

Effective Combination of Different Surgical Strategies for Deep Sternal Wound Infection and Mediastinitis

Lachmandath Tewarie, MD, Ajay K Moza, MD, PhD, Mohammad Amen Khattab, MD, Rüdiger Autschbach, MD, PhD, and Rashad Zayat, MD

Purpose: Timing and ideal reconstructive approach in deep sternal wound infection (DSWI) and mediastinitis still remain controversially debated. We present our own combined surgical strategy of bilateral pectoralis major muscle flap (BPMMF) or omental flap (OF) transposition.
Methods: Between July 2010 and July 2016, poststernotomy patients with DSWI and mediastinitis underwent a secondary wound closure with modified BPMMF (Group A, center for disease control class (CDC)-II, n = 21; Group B, CDC-III, n = 20) or with OF (Group C, CDC-III, n = 19) following vacuum-assisted closure (VAC).
Results: Significant risk factors for mediastinitis (CDC-III) were chronic obstructive pulmonary disease (COPD; p = 0.001), peripheral arterial disease (PAD; p = 0.012), cardiopulmonary bypass (CPB) time (p = 0.027), total operation time (p = 0.039), total intensive care unit (ICU) stay (p = 0.011), and blood transfusion (p = 0.049). Mean antibiotic therapy (18.4 ± 8.8[B] vs. 36.2 ± 24.4[C] days, p = 0.026) and length of hospitalization (25.2 ± 12.1[B] vs 53.8 ± 18.5 days[C], p = 0.053) were significantly longer in group C. In-hospital death was 3/19 (15.8%) in group C versus 0 in group B (p = 0.026). Frequency of recurrent mediastinitis was equal (p = 0.92); however, complications occurred more often in group C (31.6% vs. 0%, p = 0.031). The mean follow-up time was 111 ± 62 days.
Conclusion: In younger (<70 years) patients without sternal bone necrosis, the BPMMF is superior to the OF technique with relatively low recurrence and mortality risks.

Keywords: deep sternal wound infection, mediastinitis, bilateral pectoral major muscle flap, omental flap

Introduction

Poststernotomy deep sternal wound infections (DSWI) and mediastinitis are serious complications in cardiac surgery patients. Delayed diagnosis and treatment can lead to severe morbidity and even mortality. Its incidence is reported between 1% and 3% and complications are associated with a significant mortality between 10% and 50% depending on the literature.[1–6] Incidence and mortality rates remained virtually constant over the past decade since older and critically ill patients who were previously treated conservatively nowadays undergo cardiac surgery procedures. The excellent surgical technique is widely believed to reduce the risk of DSWI. Such technique includes maintaining effective hemostasis while preserving adequate blood supply, preventing hypothermia, gently handling adjacent tissues, and avoiding excessive use of bone wax and diathermia. Internal

Department of Thoracic and Cardiovascular Surgery, University Hospital RWTH Aachen, Germany

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Corresponding author: Rashad Zayat, MD. Department of Thoracic and Cardiovascular Surgery, University Hospital RWTH Aachen, Pauwelsstrasse 30, 52074 Aachen, German
Email: rzayat@ukaachen.de

thoracic artery (ITA) harvesting techniques, a shortening of on-pump time, removal of devitalized tissues, and eradication of dead space are as important as the adequate use of drains and suture material and appropriate wound closure and postoperative wound care. Surgical treatment strategies include closed irrigation and radical debridement with reconstructive procedures using pectoralis major, rectus abdominis, or omentum flaps. Although good results have been reported from the latter, it is an extensive, two-cavity surgical procedure.[4–8] The surgical challenge increases if re-operation is indicated. Omentum flap strategy is not standardized and varies between surgeon and clinic.[9–11] Numerous pedicled muscle flaps were introduced for the treatment of complex wounds, including pectoralis major, rectus abdominis, and latissimus dorsi. The use of these flaps found ready application as an alternative to omentum in the management of the sternal wound infection (SWI) and continued the trend in mortality reduction.[5,7,12] What we need is a surgical technique, which is less invasive, easy to perform, and cost-effective yielding high success rates at the same time. We want to present our own combined surgical strategies in which modified pectoralis major or omental flap (OF) transposition plays a key role.

Materials and Methods

In this retrospective study from July 2010 until July 2016, 60 poststernotomy patients (38 males) with DSWI (n = 21) and mediastinitis (n = 39) after primary debridement and vacuum-assisted closure (VAC) therapy were included. Patients previously underwent a variety of cardiac surgery procedures including coronary artery bypass grafting (CABG) (75.7%), valve replacement, aortic reconstruction (8.1%), and combinations of these procedures (16.2%). Wounds were classified according to the center for disease control (CDC) classification: (I) Superficial SWI: involving only skin or subcutaneous tissue of the incision; (II) DSWI: involving deep soft tissues (fascial and muscle layers) of the incision; (III) mediastinitis: involving sternal bone and mediastinal space, opened or manipulated during the operative procedure. DSWI was diagnosed by clinical examination (local infection signs, fistulas, fever), laboratory findings (leukocytosis, C-reactive protein) or computed tomography (CT) scan (retrosternal fluid collection, sternal dehiscence). In all cases, the diagnosis was confirmed by microbiological examination. Wound cultures were taken prior to debridement and wound cleansing. Additionally, two sets of wound swabs were sent for immediate Gram staining and culture. Once a mediastinal infection became evident, appropriate antibiotics were administered based on culture and sensitivity results. The sterilizing and antibiotic regimen were similar in all groups. For sterilization of the operation site, we use standard povidone-iodine. All patients undergoing cardiac surgery in our department routinely receive Mupirocin nasal ointment on the day before operation and a single shot of perioperative prophylactic antibiotics with either ampicillin/sulbactam (Unacid) or, if a patient has a penicillin allergy, clindamycin.

Postoperative wound management consists of daily wound care based on a non-touch technique. Cleansing the wound with povidone-iodine is sufficient, unless there are signs of DSWI, operative wound debridement, and VAC-sealing procedure was performed in all patients. For covering the wound and drains, we use a standard transparent adhesive bandage with a central absorbent pad.

Included patients underwent secondary wound closure with modified bilateral pectoral musculocutaneous flap (BPMF) (Group A, CDC class II, n = 21; Group B, CDC class III, n = 20) or with OF (Group C, CDC class III, n = 19).

Surgical wound closure

General anesthesia was administered to all patients prior to surgery. Necrotic skin and adjacent hyperplasic tissue of the sternum were excised. When fistulous tracts were present, they were thoroughly excised. All foreign materials including steel wires were removed and temporary VAC was applied to seal the wound, concomitantly stabilizing the chest wall to prevent paradoxical movements. Wound edges were approximated with traction loops, which reliably prevent retraction of the soft tissue and thus facilitate secondary wound closure during following surgery. Vacuum therapy was continued until the wound appeared macroscopically clean, granulation tissue had formed and microbiology results revealed no remaining bacterial contamination. Our final step before secondary wound closure was similar in all groups: All granulation tissue was erased and the wound repeatedly flushed with normal saline. Mechanical stability of the sternum was achieved with figure of eight-shaped Polydioxanone (PDS) or Vicryl (Ethicon Inc., Somerset NJ, USA) sutures (Group A, 8/21) or re-wiring with eight single steel wires (Group A, 13/21, Group B, 7/20), modified Robicsek technique (Group B, 10/20) or titanium steel plates (Group B, 3/20). In group C, no sternal stabilizing

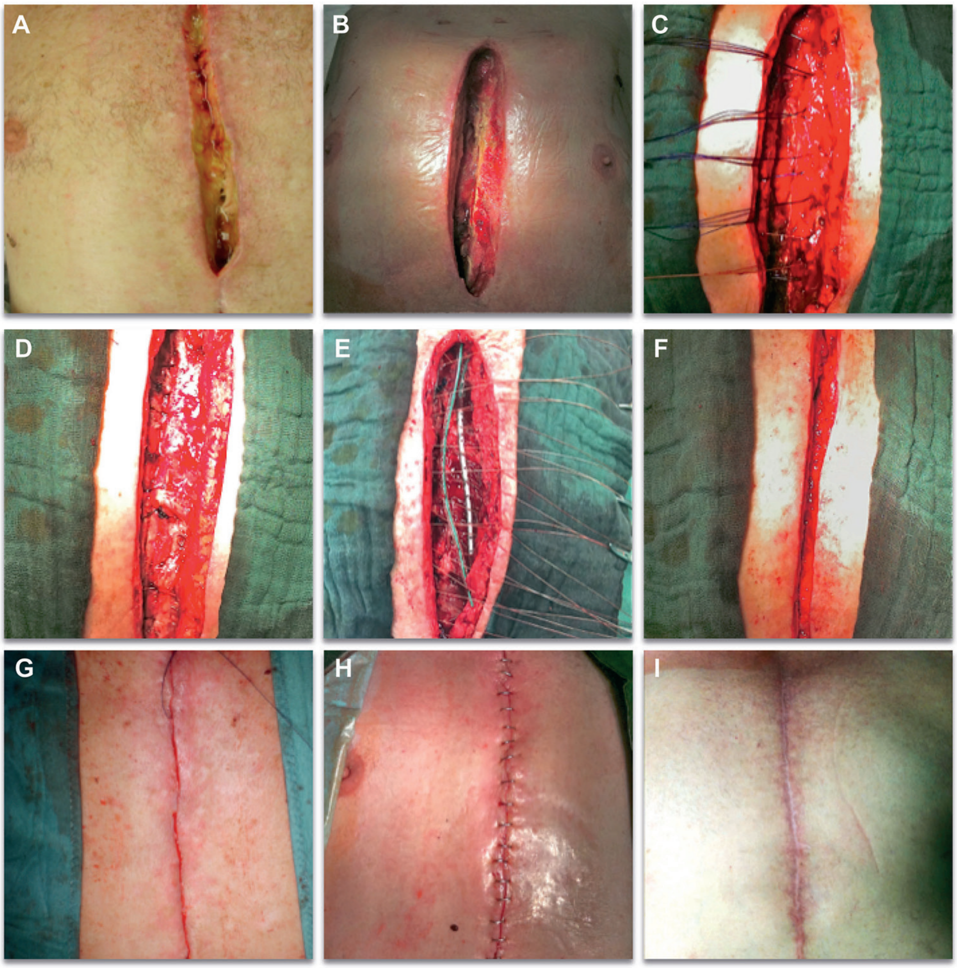

Fig. 1 Surgical closure technique with BPMMF. (**A**) CDC class III mediastinitis post-median sternotomy with complete sternal dehiscence; (**B**) 6th day post-negative pressure therapy; the sternal wound is macroscopically clean with vital granulated tissue. Microbiological cultures were negative. (**C** and **D**) Debridement and approximation of both hemi-sterni with Vicryl plus V40 (Ethicon). (**E**) Mobilized BPMMF. 16 CH Redon drains *in situ*; (**F**) approximated BPMMF; (**G**) subcutaneous wound closure; (**H**) skin clamp closure; (**I**) 6th postoperative week. BPMMF: bilateral pectoralis major muscle flap; CDC: disease control class; Vicryl: Ethicon Inc., Somerset NJ, USA

techniques were used. The reason, for no sternal stabilization in group C, was severe impairment of sternal bone and soft tissue healing. In this group, patients were older with sternal necrosis due to severe diabetes, angiopathy, usage of the bilateral internal mammary artery (IMA), and patients after thorax radiation therapy.

Bilateral pectoral major muscle flap

In groups A and B, a modified bilateral pectoralis major muscle flap (BPMMF) with adjacent subcutaneous tissue was mobilized for 5–8 cm starting from the mid-sternal thorax wall up to lateral of the mid-clavicular line. Care was taken not to injure the lateral muscle insertion of the pectoral muscles. Pectoral muscle flaps were dissected from the thorax wall without damaging collateral vessels. The BPMMF were transposed to cover the damage site and to obliterate the dead space. The flaps were sutured with Vicryl 1/0 interrupted sutures (**Fig. 1**). Our modification of the BPMMF is as follows: The BPMMF were not completely mobilized from sternal bone to its humeral attachment, but as we mentioned in earlier in this section, it was mobilized for 5–8 cm starting from the mid-sternal thorax wall up to lateral of the mid-clavicular line. We did not dissect the flap to the anterior axillary fold. After bilateral dissection of 8 cm from thorax wall, because of elasticity of the flap, it reaches comfortably across the midline. Transposition and adaptation of the BPMMF were done using eight

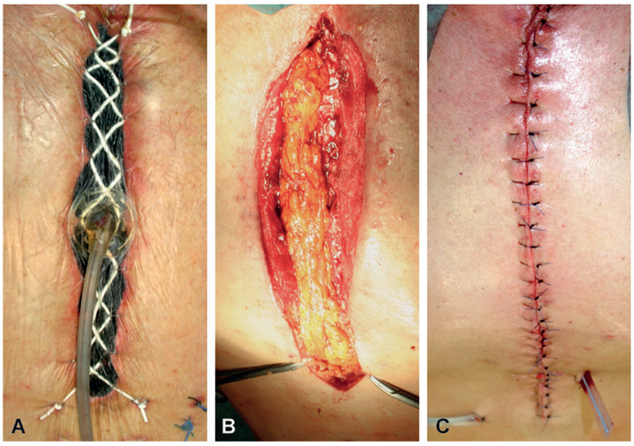

Fig. 2 OF technique. (**A**) Temporary VAC. Wound edges were approximated with traction loops, which reliably prevented retraction of the soft tissue, (**B**) completely filling the mediastinal dead space with mobilized pedicled omentum flap, and (**C**) followed by a pectoralis advancement flap to accomplish a tension-free skin closure. OF: omental flap; VAC: vacuum-assisted closure

U-shaped intermittent retention sutures. A Prolene one suture was used 5 cm distance from the median cut edge, the needle withdraws through the skin and full BPMMF thickness to the opposite site in a U-shape. The BPMMF were transposed to cover the damage site and to obliterate the dead space. The flaps were sutured with Vicryl 1/0 interrupted sutures.

The Prolene retention sutures were knotted, and the knot was tightened with a rubber tube.

This was repeated every 4-cm distance of the median wound length. The skin was closed with Donati Ethilon Sutures or with staplers.

Drainage tubes connected to negative pressure bottles were placed sub-pectoral and in subcutaneous space near the incision to prevent large dead space seroma. In some cases, the subcutaneous tissue was mobilized from the BPMMF and approximated using a continuous Vicryl 1/0 tension free suture. The skin was closed with metal skin staples.

Omentum flap procedure

In group C, the wound closure was accomplished by mobilizing a pedicled omentum flap (**Fig. 2**), completely filling the mediastinal dead space followed by a pectoralis advancement flap to accomplish a tension-free skin closure. A short upper midline incision was made from the previous sternotomy wound to the upper part of the abdomen. The omentum was transposed to the anterior mediastinum through a tunnel created on the anterior surface of the diaphragm muscle. Fixation of the omentum to the diaphragm and the aponeurosis of the rectus abdominis muscle were performed to prevent herniation.

Patients selection for the different strategies

Younger (<70 years) patients without sternal bone necrosis were selected for the BPMMF Technique. Older patients (>70 years) with sternal bone necrosis, patients with aortic vascular grafts in situ, severe impairment of wound healing (prednisone therapy, severe diabetes mellitus, angiopathy, usage of bilateral IMAs), another reason was that the used strategy varies between surgeons in our clinic

Follow-up examination

The long-term follow-up consisted of telephone interviews with the patients and their primary care physicians. The patients were asked to comment on their general and aesthetic satisfaction, chest wall pain at rest, painful rubbing and clicking of the bony edges in rest and during physical activity, need for pain medication, restriction of daily activities and physical condition compared to before operation. Mortality was defined as death directly related to SWI or death within 30 days after reconstruction.

Statistics

Continuous variables are expressed as mean ± standard deviation (SD) and categorical variables as absolute numbers and percentages. Data analysis was performed with IBM SPSS Statistics, version 23 (IBM Corporation, Chicago, IL, USA). Categorical variables were analyzed with a Chi-Square test or, if appropriate, Fisher's exact test. Continuous variables were analyzed using Student's *t*-test. A p value <0.05 was considered statistically significant.

Results

Demographics

In comparison to groups A and C, group B contained a relatively higher number of high-risk patients. In the total cohort, SWI with sternal destruction occurred in 53.3% of all cases (32/60). The most important risk factors for DSWI and mediastinitis were diabetes mellitus (A: 28.6%; B: 50%; C: 42.1%), chronic obstructive pulmonary disease (COPD) with Global Initiative for Chronic Obstructive

Table 1 Description of preoperative clinical characteristics, surgical technique and ICU-stay

Group	A (N = 21)	p value A vs. B	B (N = 20)	p value B vs. C	C (N = 19)
Sternum plastic	Pectoral flap		Pectoral flap		Omental flap
Gender (%)		0.065		0.352	
Male	71.4		55		63.2
Female	28.6		45		36.8
Age (years)	63.7 (±11.1)	**0.017**	70.1 (±7.2)	0.580	70.3 (±10.2)
COPD	71.4%	0.43	75%	**0.001**	42.1
Nicotine	71.4% (15/21)	0.846	70% (14/20)	0.079	52.6% (10/19)
BMI (Kg/m^2)	28.8 (±4.1)	0.903	28.5 (±4.3)	0.518	29.7 (±5.7)
DM	28.6%	0.186	50%	0.121	36.8%
PAD	28.6%	0.865	45%	**0.012**	15.8%
Kidney failure	14.3%	**0.016**	30%	0.260	21%
Emergency cases	19% (4/21)		15% (3/20)		21% (4/19)
CABG	71.4%	0.880	70%	0.476	68.4%
LITA	61.9%	0.884	70%	0.90	68.4%
BITA	19.1%		20%		21%
Valve	9.5%	-	10%	-	5.3%
Other	19.1%	-	20%	-	26.3%
OPCAB	14.3% (3/21)	-	10% (2/20)	-	10.5% (2/19)
CPB-time (min)	91.3 (±58.4)	0.395	91.3 (±43.9)	**0.027**	124.4 (±43.8)
Operation time (min)	209.9 (±65.6)	0.930	212.7 (±75)	**0.039**	260.7 (±60.4)
ICU-stay (days)	4.1 (±3.2)	0.066	5.8 (±5.3)	**0.011**	9.5 (±10.1)
Ventilation time (days)	1.6 (±2.3)	0.207	2.3 (±3.4)	0.423	2.8 (±3.8)
Tracheotomy	4.8% (1/21)	0.052	15% (3/20)	0.140	15.8% (3/19)
Post-OP complications	38.1% (8/21)	0.621	65% (13/20)	0.887	78.9% (15/19)
Pulmonary infection	9.5% (2/21)	-	25% (5/20)	-	15.8% (3/19)
Delirium	19.0% (4/21)	-	25% (5/20)	-	42.1% (8/19)
Sepsis	4.8% (1/21)	-	5% (1/20)	-	10.5% (2/19)
Re-sternotomie	0%	-	10% (2/20)	-	5.3% (1/19)
Transfusion (packed cells)	2.05 (±1.09)	0.795	2.2 (±0.98)	**0.049**	2.8 (±0.93)
Acute renal failure	4.8% (1/21)	-	5% (1/20)	-	5.3% (1/19)
Microbiological species isolated from sternal wound					
S. aureus, n (%)	6 (28.6)	0.742	7 (35)	1.000	7 (36.8)
S. epidermidis	6 (28.6)	0.093	1 (5)	0.596	2 (10.5)
MRSA	1 (4.8)	0.343	3 (15)	0.607	1 (5.3)
E. coli	2 (9.5)	0.662	3 (5)	0.232	0
Enterobacter	0	-	0	0.219	2 (10.5)
Klebsiella oxytoca	1 (4.8)	0.343	3 (5)	0.232	0
S. marcescens	1 (4.8)	0.343	3 (5)	0.607	1 (5.3)
P. aeruginosa	1 (4.8)	1.000	0	0.475	1 (5.3)
Candida albicans	1 (4.8)	0.343	3 (5)	0.607	1 (5.3)

Bold values indicates significance. BMI: body mass index; COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; PAD: peripheral arterial disease; CABG: coronary artery bypass graft; Other: other open heart surgery procedures; LITA: left internal thoracic artery; BITA: bilateral internal thoracic artery; OPCAB: off pump coronary artery bypass grafting; CPB time: total cardiopulmonary bypass time; Operation time: total operation time; S. aureus: Staphylococcus aureus; *S. epiderimidis: Staphylococcus epidermidis;* MRSA: methicillin-resistant *Staphylococcus aureus; E. coli: Escherichia coli; S. marcescens: Serratia marcescens; P. aeruginosa: Pseudomonas aeruginosa*.

Table 2 Therapy-related complications and recurrence in groups A and B

Group	A (N = 21)	B (N = 20)	p value
Recurrence	-	10% (2/20)	0.002
Mortality	-	5% (1/20)	0.276
Complications	0	0	-
Length of hospital stay (days)	22.3 (±11.2)	25.2 (±12.4)	0.743
Total duration antimicrobial therapy (days)	17.5 (±9 .2)	18.4 (±9.0)	0.94
Follow-up time (days)	60.5 (±19.8)	146 (±32)	-

Lung Disease (GOLD) stage > 2 (A: 71.4%; B: 75%; C: 42.1%). Mean age was 63.7 ± 11.1 (A), 70.1 ± 7.2 (B), and 70.3 ± 10.2 (C) years. The mean Body Mass Index (BMI) was 28.8 ± 4.1 (A), 28.5 ± 4.3 (B), and 29.7 ± 5.7 (C) kg/m^2. Chronic kidney failure was found in 14.3% (A), 30% (B), and 21% (C) of patients. Peripheral arterial disease (Fontaine > type 2) was present in 28.6% (A), 45% (B), and 15.8% (C).

For DSWI, only age (p = 0.017) and preoperative kidney failure (p = 0.016) differed significantly between groups. Statistically significant risk factors for the occurrence of mediastinitis (CDC class III) were COPD (p = 0.001), peripheral arterial disease (PAD; p = 0.012), cardiopulmonary bypass (CPB) time (p = 0.027), total operation time (p = 0.039), total intensive care unit (ICU) stay (p = 0.011), and blood transfusion (p = 0.049). The patients' demography and operative data are summarized in **Table 1**. Other risk factors (nicotine use, BMI, diabetes, emergency procedure, off pump coronary artery bypass grafting [OPCAB], type of surgical procedure, use of IMA, tracheotomy, previous postoperative complications during ICU stay) were similar in all groups.

The incidence of DSWI was similar in all groups, ranging on average between 22.7 ± 11.2 (A), 21 ± 8.3 (B), and 18.6 ± 7.9 (C) days after surgery.

Mean VAC therapy durations were 8.5 ± 6.9 (A), 8.8 ± 9.3 (B), and 11.2 ± 8.6 (C) days, respectively. Wound cultures were collected after every VAC dressing change. Microbial cultures revealed Gram-positive species in 56.7% (34/60) and Gram-negative species in 20% (12/60) (**Table 1**). In 5% (3/60), *Candida albicans* was isolated. In 18.3% (11/60), no microbial species were found. The antibiotic therapy was continued or adjusted depending on microbiological culture and resistances.

BPMMF therapy: groups A (DSWI) and B (mediastinitis) (n = 41)

All patients were extubated in the operation room and moved to the recovery area. The mean operation time was 28.5 ± 13.2 (A) and 37.8 ±15.6 (B) minutes. All patients were discharged after recovery and the mean length of hospital stay was equal in both groups (22.3 ± 11.2 days [A] vs. 25.2 ± 12.4 days [B], p = 0.743). Skin staples were removed between the 10th and 12th postoperative days. On discharge, all sternal wounds except for one were macroscopically clean and surrounding tissue was vital. Success rates were 100% in group A and 95% (19/20) in group B. In the post-discharge period, treatment failure occurred in 10% (2/20) of group B patients. One patient developed a chronic sternal fistula caused by a multi-resistant staphylococcus epidermidis. In this case, the surgical fistula was excised and antibiotic therapy with vancomycin was administered. The second patient developed a superficial sternal infection caused by *Candida albicans*. After local wound debridement and intravenous therapy with Diflucan (fluconazole; Pfizer Inc., NY, USA) for 1 week, the patient was discharged on oral Diflucan therapy for another 5 weeks. In both cases, the wound healed completely within 4 weeks. The mean antibiotic treatment time was 17 ± 9 (A) and 18 ± 9 (B) days. The mean follow-up time was 60 ± 20 (A) and 146 ± 32 (B) days (**Table 2**). One patient died due to a non-surgical related cause (cerebrovascular).

BPMMF (B, n = 20) versus OF therapy (C, n = 19)

Mediastinitis was diagnosed after 21 ± 8 (B) and 16 ± 8 (C) days post-cardiac surgery. Wound closure was performed after 16 ± 12 (B) compared to 23 ± 13 (C) days. In group C, patients who did not require ventilatory support prior to OF transposition were extubated in the operating room within 6 hours after surgery. In group B, all patients were extubated in the operating room. The mean antibiotic treatment time was significantly shorter in the BPMMF group (18 ± 9 [B] vs. 36 ± 25 [C] days, p = 0.026). Though significance was not reached, there was a trend toward the prolonged length of hospital stay in group C (54 ± 19 vs 25 ± 12 days, p = 0.053. 30-day mortality in both groups was 0%). In-hospital mortality

Table 3 Therapy-related complications and recurrence in groups B and C

Group	B (N = 20)	C (N = 19)	p value
Recurrence	10% (2/20)	10.5%(2/19)	0.92
Mortality	0	15.9% (3/19)	**0.026**
Infection related	0	10.5% (2/19)	-
Other cause	5% (1/20)	5.3% (1/19)	-
Complications	**0**	**31.6% (6/19)**	**0.031**
Bleeding	-	5.3% (1/19)	-
Skin necrosis	-	5.3% (1/19)	-
Epigastric hernia	-	21% (4/19)	-
Length of hospital stay (days)	25.2 (±12.4)	53.8 (±19.0)	0.053
Total duration antimicrobial therapy (days)	18.4 (±9.0)	36.2 (±25.1)	0.026
Follow-up time (days)	146 (±32)	127 (±50)	-

Bold value indicates significance.

was significantly higher in group C (0/20 [B] vs. 3/19 [C; 15.8%] patients, p = 0.026). One patient in group C was a high-risk patient (log EuroScore: 47.7%; age 86 years), and cardiac surgery followed by a two-cavity procedure proved to be too consumptive. This patient died in septic multiorgan failure. However, there was no evidence for peritonitis or formation of intra-abdominal abscess in this patient. Another patient died in septic multiorgan failure from mediastinitis-related endocarditis. The third patient died during follow-up for reasons that were not related to the OF procedure.

Recurrence of mediastinitis was similar in both groups. However, complications as summarized in **Table 3** were more often observed in group C (31.6% vs. 0%, p = 0.031). In one patient, secondary wound closure failed due to skin necrosis. This patient had to be referred to plastic surgery for further reconstruction with vertical musculocutaneous rectus abdominis flap. This however only became possible because mediastinitis had been successfully treated previously by covering the huge mediastinal dead space with viable omentum. One patient developed a small superficial fistula, which was successfully treated by local wound care. Nevertheless, this patient had to undergo surgery for the epigastric hernia. In both groups, all survivors were satisfied, especially with the aesthetic result. No major complications associated with OF transpositions (peritoneal contamination or gastric traction) were noted among the survivors. In four patients, small epigastric herniation without functional limitation was found. Reconstructive surgery did not cause any limitations. During follow-up, patients' satisfaction was unanimously high, only one patient complained of minor pain during physical activity. The mean follow-up time was 146 ± 32 (B) and 127 ± 50 (C) days.

Discussion

Sternal bone infections in mediastinitis after median sternotomy lead to a high mortality. In the largest series to evaluate the outcome of the infected sternum after debridement followed by muscle flap coverage, early mortalities vary between 2% and 10.9%[13–15] with most deaths related to a persistent infection with subsequent mediastinitis and sepsis. Early postoperative mortality is strongly determined by the control of sternal infection. In our study, there was no 30-day mortality in both treatment strategies (B and C). Most importantly, none of the deaths in group B were caused by recurrent sternal infection or mediastinitis.

In literature, recurrent infection is reported to occur in 22% to 52% of cases after debridement, sternal refixation, and mediastinal catheter irrigation and in 3% to 26% of cases after debridement, sternal refixation, and muscle flap coverage.[13,16,17] Studies were also aimed at combined application of the BPMMF and rectus abdominis flaps or omentum. Using well-vascularized tissues to fill the damaged area promotes rapid healing. However, concomitant use of both described techniques cannot be recommended according to available clinical data.[18] The greater omentum flap provides excellent vascular supply and is capable of surviving even in highly contaminated fields.[18–21] However, epigastric herniation, graft bleeding, necrosis, and contamination of the peritoneal cavity are serious complications. Moreover, re-do cardiac surgery procedures are heavily complicated by a pre-existing omentum flap. The surgical procedure affects sternal stability and the local function of the trunk. Aesthetic acceptance is often reduced compared to the BPMMF transposition.[13,19,20,22]

In our study, several surgical techniques were used to fill the damaged sternal defect. We preferred wound debridement with negative pressure therapy followed by BPMMF or OF plastic. The advantages of the BPMMF are determined by its anatomy. It is richly vascularized by branches from the thoracoacromial artery and perforating branches of the ITA. After the ITA has been harvested, the pectoral major flap is still well vascularized. It is adjacent to the sternum and due to the elasticity of the bilateral pectoral major flap, it is easily transpositioned and fills the sternal defect completely. During the transposition, the lateral insertion into the humerus was retained and a shoulder dysfunction was prevented. No additional incision was needed and a tension-free edge-to-edge wound closure was possible. The aesthetic and functional results are superior as compared to a vertical musculocutaneous rectus abdominis flap, often creating a skin paddle on the chest, which is responsible for a less satisfactory aesthetic result.[23] Besides the aesthetic result, the BPMMF group had less recurrence and no herniation compared to the OF group (21% [4/19]). The economic impact of postoperative mediastinitis has also been evaluated in several studies.[3,4] Patients with mediastinitis were shown to be hospitalized 20 days longer than patients without this complication. Although it did not reach statistical significance, our study showed a strong trend toward a prolonged hospitalization in the omental group in comparison to the BPMMF group.

Conclusion

BPMMF is a cornerstone in our treatment concept of DSWI. Our algorithm combines early systemic antibiotic therapy with staged surgical procedure, starting with a multistep negative pressure wound therapy and definitive wound reconstruction with BPMMF. The BPMMF procedure can be accomplished earlier, it is safe, and it provided satisfactory clinical and aesthetical results. This justifies the invasive nature of the BPMMF procedure and suggests this application as a primary approach in younger (<70 years) patients without sternal bone necrosis. Omentoplasty and the combinational approach remain as exceptional alternatives when other strategies fail.

Disclosure Statement

The authors declare that they have no conflict of interest.

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