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CASE REPORT

Simultaneous pectoralis major-latissimus dorsi myocutaneous flap: An option of reconstruction for open sternal wounds

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Summary Management of the open sternal wound after surgery is a challenge. We report a retrospective series of cases with regard to the management of sternal wounds according to our own experience and a review of the related literature. A retrospective chart review from June 2007 to February 2010 of patients with infective and open sternal wounds after surgery was performed. There were seven patients with a previous history of type A aortic dissection treated with the Bentall operation, thymoma with excision, mitral and tricuspid regurgitation with double valve replacement, and acute myocardial infarction with a ventricular-assist device or coronary artery bypass graft. All wound cultures of the seven patients showed positive findings. All patients received the latissimus dorsi (LD) myocutaneous flap for lower sternal wound reconstruction under the decubitus position and a contralateral pedicled rotated pectoralis major (PM) myocutaneous flap for the upper sternal wound. The residual wound was covered with a split-thickness skin graft. The mean age of the seven patients, including four males and three females, was 58.1 years (range: 33–73 years). The mean follow-up was 37.7 months (range: 30–44 months). The average time span between the final débridement and the flap reconstruction procedure was 5.2 ± 1.8 days. The harvested area of LD myocutaneous flap ranged from $25 \times 10\ cm^2$ to $15 \times 8\ cm^2$, and the area of PM myocutaneous flap ranged from $15 \times 15\ cm^2$ to $10 \times 5\ cm^2$. Four of seven patients had an omental flap initially, but salvage surgery was performed using a simultaneous pectoralis major-LD flap. Three cases underwent simultaneous PM-LD flap directly. One patient expired on postoperative Day 4 because of sudden ventricular fibrillation, but no postoperative complications were noted in the other six patients. With long-term follow-up, all patients

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survived without significant complications. The simultaneous PM-LD myocutaneous flap is a reliable option for open sternal wound reconstruction.

1. Introduction

Many factors are closely related to poststernotomy sternal wound infection, including diabetes, chronic obstructive pulmonary disease, body mass index $>$ 30, old age, long-term use of corticosteroids, reoperation as a result of bleeding complications, kidney failure, prolonged ventilator use, cardiopulmonary resuscitation maneuvers, and smoking.[1] The current treatments for sternum wound infection include débridement, antibiotics, wound management, and flap transfer for dead space obliteration. Considering the different locations of sternal wound infection, omental or muscle flaps are suggested for wound coverage, although there is no definite evidence advocating one option over the other.[2]

An infective and open sternal wound infection is much more difficult to deal with than an original clean wound. The challenges include a large dead space with exposure of the aorta, difficulty in completely eradicating or excising infected tissue around the vessel, unstable hemodynamics, and comorbidities. Related studies for open sternal wound reconstruction have been rarely reported. The simultaneous pectoralis major-latissimus dorsi (PM-LD) myocutaneous flap is an option for infective and open sternal wound reconstruction because of its adequate volume, high resistance to wound infection, and good tissue survival even under inotropic use. In this study, we present our experiences in the management of infective and open sternal wounds with a 3-year follow-up.

2. Patients and methods

We reviewed charts from June 2007 to February 2010, retrospectively. Seven patients (4 males, 3 females) with an open sternal wound with or without graft exposure after reconstruction were included. Their ages ranged from 33 years to 73 years (mean: 58.1 years). All wound cultures showed positive findings. The mean surgery time was 441.3 minutes (range: 376—605 minutes). The mean Charlson index score was 4 points (range: 3—6 points). The sternal wound was the result of various surgeries, including the Bentall operation for type A aortic dissection, excision of thymoma, double-valve replacement for mitral and tricuspid regurgitation, and use of a ventricular assist device (VAD) or coronary artery bypass graft (CABG). The patient details are summarized in Table 1.

2.1. Surgical technique

The flaps were harvested with patients placed in the right decubitus position (Fig. 1A). An incision was made along the border of the LD muscle, and the loose alveolar tissues between the LD and serratus anterior muscles were dissected toward the axilla until the branch of the thoracodorsal artery. Under considerations of both the primary closure of the donor site and the size of the lower sternal wound, the upper limit of the skin paddle width was kept at approximately 8—9 cm and a large amount of fascia and muscle was incorporated during LD flap harvesting. A subcutaneous pocket at the left chest was elevated to facilitate lateral transposition of the flap. The wound was partially closed with investing sutures that were inserted between the skin and the underlying tissue bed. Approximately 10 cm of the wound was left open so that the tension on the pedicle could be adjusted during transposition of the flap. A suction drain was inserted for postoperative drainage. The patient was then placed to the original supine position, and the irregular edge of the wound was trimmed. A subcutaneous tunnel was created to be connected with the pocket previously made. The flap was inset with the distal part of muscle inserted into the space of the sternal wound to cover the lower aortic graft (Fig. 1B).

The upper part of the graft was covered with the right-pedicled rotation pectoralis major muscle, which was raised, based on the right thoracoacromial vessels. The humeral insertion and clavicular attachment were released in order to increase the arc of rotation of the flap. The wounds were closed with 2-0 polydioxanone sutures. The residual donor site was covered with a split-thickness skin graft (Fig. 2).

3. Results

The mean follow-up period was 37.7 months (range: 30—44 months). The average time span between the final débridement and the flap reconstruction procedure was 5.2 $\pm$ 1.8 days. Four of the seven patients had an omental flap initially but the procedure failed; salvage surgery was performed using a simultaneous PM-LD flap. Three patients underwent a simultaneous PM-LD flap directly. One patient expired on postoperative Day 4 as a result of sudden ventricular fibrillation. The harvested area of the LD myocutaneous flaps ranged from 25 $\times$ 10 cm^2 to 15 $\times$ 8 cm^2, and the areas of PM myocutaneous flap ranged from 15 $\times$ 15 cm^2 to 10 $\times$ 5 cm^2. No immediate complications were noted in the other six cases. With long-term follow-up, all patients survived without significant complications. Case 1 is discussed in the next paragraph.

A 73-year-old woman had acute type A aortic dissection with hemopericardium, malperfusion syndrome, and cardiogenic shock. A Bentall operation was performed with aortic valve replacement and aortobilateral femoral bypass. Because of persistent oozing, the wound was closed with a Bogota bag to prevent cardiac tamponade. Five days

Table 1 Summary of cases.

Case no.	Age (y)/Sex	Diagnosis	Wound culture	Antibiotics	Previous flap reconstruction	Inotropics use	Time span from débridement to definitive flap procedure (d)	Surface area of flap (cm^2)	Charlson index score	Surgical time (min)	Follow-up (mo)	Current status
1	65/M	Type A aortic dissection s/p Bentall	*Staphylococcus aureus; Klebsiella oxytoca*	Teicoplanin + Metromidazol	Omental flap	+	6	PM: 15 × 15; LD: 8 × 15	4	404	30	Alive
2	33/M	Type A aortic dissection s/p Bentall	*Acinetobacter baumannii/ calcoaceticus complex*	Tigecycline	Omental flap	+	8	PM: 10 × 5; LD: 25 × 10	4	482	31	Alive
3	65/F	MR, TR s/p double valves replacement	*Klebsiella pneumoniae*	Ertapenem	-	+	4	PM: 15 × 10; LD: 15 × 8	3	605	33	Alive
4	56/M	AMI, CAD, cardiogenic shock s/p VAD	*Serratia marcescens; Klebsiella pneumoniae*	Cefepime	Omental flap	+	3	PM: 12 × 8; LD: 20 × 8	4	381	44	Alive
5	46/F	Acute subendocardial infarction s/p CABG	*Candida tropicalis*	Fluconazole	-	-	6	PM: 10 × 13; LD: 9 × 18	3	376	44	Alive
6	73/F	Type A aortic dissection s/p Bentall	*Enterobacter cloacae; Proteus mirabilis*	Ertapenem	Omental flap	+	4	PM: 15 × 10; LD: 18 × 8	4	432	44	Alive
7	69/M	Thymoma s/p excision	*S. aureus* (MRSA)	Tigecycline	-	-	4	PM: 8 × 13; LD: 9 × 22	6	409	-	Expired

AMI = acute myocardial infarction; CAD = coronary artery disease; CABG = coronary artery bypass graft; LD = latissimus dorsi; MRSA = methicillin-resistant *S. aureus*; PM = pectoralis major; TR = tricuspid regurgitation; VAD = ventricular assist device.

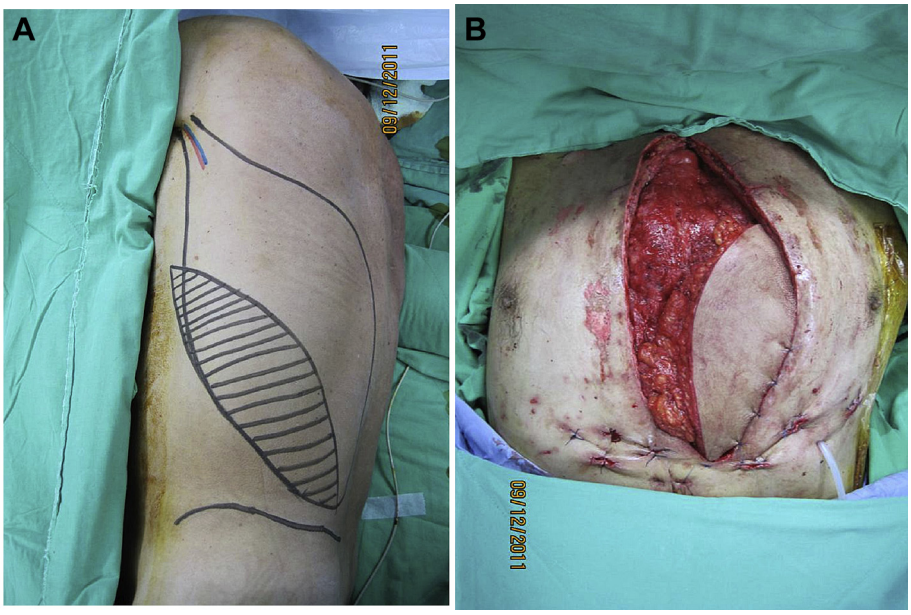

Figure 1 (A) The latissimus dorsi myocutaneous flaps were harvested with the patient in the right decubitus position. (B) The harvested latissimus dorsi myocutaneous flap was transpositioned for lower sternal wound reconstruction.

later, the packing gauze was removed and the sternal wound closed with an omental flap. On postoperative Day 13, wound dehiscence with pus was found, and the patient underwent sequestrectomy of the sternum with removal of sternal wires (Fig. 3). Wound culture showed *Enterobacter cloacae* and *Proteus mirabilis*. After débridement, the aforementioned simultaneous PM-LD flap was designed and a split-thickness skin graft was harvested later for donor site surfacing. The flap survived completely and the wound healed uneventfully 12 months later (Fig. 4).

4. Discussion

Reconstruction of infective and open sternal wounds after surgery presents a challenge to surgeons. The gold standard treatments consist of radical débridement, antibiotic therapy, extra-anatomical bypass, and graft removal. However, even simple débridement (in addition to radical débridements or graft change) may run the risk of unstable hemodynamics. Therefore, adequate débridement should be accompanied by vigorous hemodynamic management, meticulous wound care, nutritional support, and flap coverage to achieve a better outcome. Various studies provided different options for sternal wound reconstruction: for different positions of sternal wound infection, Greig et al[3] suggested the PM flap for upper sternum wounds and simultaneous pectoralis major-rectus abdominis (PM-RA) muscle flap for lower or whole sternum wounds. Kaye et al[4] advocated varying reconstructive procedures according to different categories of cardiac surgery applied. As such, patients with CABG and CABG with valve

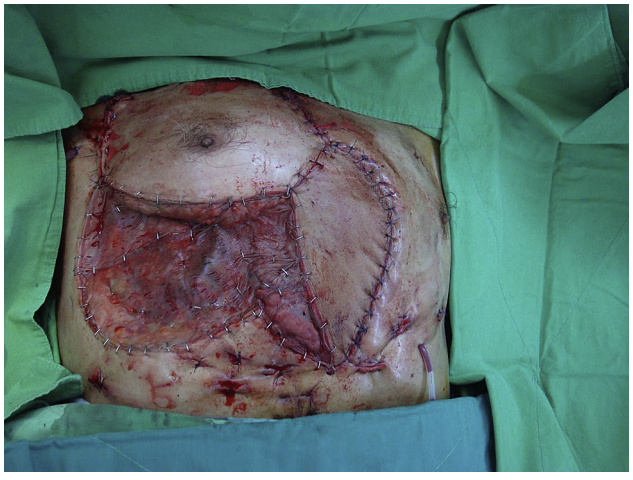

Figure 2 Right pedicled rotation of the pectoralis major myocutaneous flap harvested for upper sternal wound reconstruction. The residual wound was covered with a split- thickness skin graft.

Figure 3 An exposed sternal wound with graft exposure in a 73-year-old woman with acute type A aortic dissection with the Bentall operation, aortic valve replacement, and aortobilateral femoral bypass.

Figure 4 Postoperative photograph at 12-month follow-up of the patient described in Fig. 3.

most frequently received right pectoralis muscle turnover flaps or left pectoralis muscle advancement flaps, and 10 heart transplant patients had omental flaps in a series reported by Kaye et al.[4] Whether a muscle or omental flap provides better coverage for sternal osteomyelitis has not yet been confirmed Lower level evidence suggests that the omental flap is superior to the muscle flap in deep sternal wound reconstruction because of lower mortality and fewer complications.

Less reconstructive methods with infective and exposed sternal wounds have been reported because of the challenges of dead space obliteration, infection control, and unstable hemodynamics. According to the studies reviewed, four methods have been reported for wide and open sternal wound reconstruction: PM-RA, PM-omental, tripedicled PM, and free vastus lateralis (VL) myocutaneous (or tensor fascia lata (TFL) + VL) flaps. Lee et al[5] reported a case with exposed sternal osteomyelitis after dissecting aortic aneurysm grafting surgery; bilateral PM muscle advancement flaps were used for upper sternum and RA muscle flap coverage of the lower sternum. Although the volume of the PM-RA flap for both upper and lower sternal wounds is sufficient, the RA flap runs the risk of unreliable blood supply because of splitting of the sternum and possible use of the internal mammary artery in previous operations. Sajjadian et al[6] presented a case series about simultaneous PM-omental flap for the exposed sternum wound with VAD exposure. The omental flap has a rich blood supply and well-developed lymphatic tissue and can reach almost every part of a sternal defect and fill irregular defects; however, the omental flap harvesting runs the risk of diaphragmatic herniation and contamination spreading from the chest into the peritoneal cavity. Tripedicled PM myocutaneous flap is easily harvested, but the insufficient volume may not fill uneven space completely. The free VL myocutaneous (or TFL + VL) flap is of good blood supply and sufficient volume, but its microsurgery is technically demanding (prompt coverage within short ischemic time) with the risk of total failure. The PM-LD myocutaneous flap may be a better choice. In addition to the resistance to severe wound infection and large and adequate volume for irregular and uneven wounds, the PM-LD myocutaneous flap has constant vascular pedicle (almost no variations), no risk involving laparotomy (spreading infection into peritoneal cavity) and microsurgery, although the limit of the position change during operation is unavoidable. The advantages and disadvantages of this flap are summarized in Table 2.

Table 2 The advantages and disadvantages of different methods for open sternal wound reconstruction.

	Advantages	Disadvantages
PM-RA	Sufficient volume for both upper and lower sternal wounds	Unreliable blood supply of RA because of splitting of sternum and possible use of internal mammary artery in previous operations
PM-omentum	Rich blood supply and well-developed lymphatic system Reaches more or less every part of a sternal defect Fills irregular defects	Spreading infection to peritoneal cavity and a risk of ventral hernia formation Laparotomy
Tripedicled PM flap	Simple and easy Does not require position change	Insufficient volume may not fill uneven space completely
Free VL muscle flap or TFL+VL	Good blood supply and sufficient volume	Needing microsurgery and prompt coverage within short ischemic time Risk of total failure
PM-LD	Large and adjustable volume for wound coverage Resistance to severe wound infection Constant vascular pedicle (almost no variations) with low risk of partial loss No laparotomy	Position change during surgery

LD = latissimus dorsi; PM = pectoralis major; RA = rectus abdominis; TFL = tensor fascia lata; VL = vastus lateralis.

When an LD myocutaneous flap is harvested completely, its size can reach $20 \times 35\ cm^2$ with the maximal skin paddle size of $12 \times 20\ cm^2$.[7] Under considerations of both primary closure of the donor site and the size of the lower sternal wound, the skin paddle (approximately 8—9 cm) with extensive fascia and muscle of LD myocutaneous flap was harvested in our study. Unlike bilateral advancement pectoralis major muscle flaps, the rotation of the contralateral pectoralis major myocutaneous flap was designed for upper sternal wound reconstruction. The humeral insertion and clavicular attachment were released to increase the arc of rotation of the flap. The advantage of rotation of the opposite PM myocutaneous flap is that only one flap is sufficient for upper sternal wound coverage, but the disadvantage is the transposition of the position of the nipple-areolar complex.

A number of shortcomings in the current series have been identified. Only a small number of patients were examined, and the procedures were carried out at a single facility, which may not be representative of all institutions. The small number of patients may account for the apparently low complication rate of the technique. Because this is a retrospective study, more cases with long-term follow-up of the treatment modality and multicenter, randomized, comparative trials are necessary.

Although findings are not conclusive, it appears that the simultaneous PM-LD myocutaneous flap is a reliable option for infective and open sternal wound reconstruction.

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