

Original Article

Our experience with pectoralis major flap for management of sternal dehiscence: A review of 25 cases

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ABSTRACT

Objective: To report our experience of the pectoralis major flap as the treatment modality for post coronary artery bypass sternal wound dehiscence. **Materials and Methods:** A retrospective study of 25 open heart surgery cases, performed between January 2006 and December 2010 at Deenanath Mangeshkar Hospital, Pune, was carried out. Unilateral or bilateral pectoralis major muscle flap by the double breasting technique using rectus extension was used in the management of these patients. The outcome was assessed on the basis of efficacy of flap surgery in achieving wound healing and post-surgery shoulder joint movements to evaluate donor site morbidity. The follow-up ranged from 5 months to 3.5 years. **Results:** Twenty-three (92%) patients were discharged with complete wound closure. One patient (4%) had wound dehiscence after flap surgery. One patient (4%) died in the hospital in the immediate postoperative period due to mediastinitis. No recurrent sternum infection has occurred till date in 24 patients (96%). For one patient (4%) who had wound dehiscence, daily dressing was done and wound healing was achieved with secondary intension. At follow-up, shoulder joint movements were normal in all the patients. **Conclusions:** The double breasting technique of the pectoralis major muscle flaps with rectus sheath extension is efficient in covering the entire length of the defect and can reduce the morbidity, without affecting the function of the shoulder joint.

KEY WORDS

Bilateral pectoralis major flaps; left internal mammary artery and right internal mammary artery; sternal dehiscence

INTRODUCTION

In 1957, the introduction of the median sternotomy

to allow access to intrathoracic organs by Julian revolutionised the field of cardiothoracic surgery.^[1] Since this landmark introduction, sternal wound infection and dehiscence have been reported to occur in 0.2–10%^[2] and mortality rates in such cases range from 05 to 20%.^[2]

The risk factors for sternal dehiscence post median sternotomy include diabetes,^[3] prolonged surgery time,^[4] prolonged postoperative ventilation,^[5] previous surgery,^[6] postoperative dialysis,^[6] postoperative

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haemorrhage,^[6] smoking, low cardiac output stage, use of either left internal mammary artery (LIMA) or right internal mammary artery (RIMA) or both^[7] and obesity.^[8]

Treatment options for sternal dehiscence include multiple debridements, resuturing/rewiring in cases which present early, vacuum-assisted closure (VAC) devices, flap cover with muscle flaps like pectoralis major, rectus abdominis, latissimus dorsi and omentum.

The possible and most devastating complication that can occur in the patients of sternal dehiscence is mediastinitis. The incidence is 47%. The mortality in such cases is as high as 50%.^[9-12]

Pectoralis major muscle flaps are used commonly in combination with rectus abdominis muscle or omentum to manage such cases. We modified this procedure by isolating pectoralis on one side, taking a rectus sheath extension on one side and double breasting both across midline. Isolating the muscle on thoracoacromial pedicle helps in extending its reach across midline and inferiorly. The rectus sheath extension helps to fill lower end of the defect.

MATERIALS AND METHODS

This is a retrospective review of 25 ($n=25$) consecutive patients of sternal dehiscence managed by unilateral pectoralis muscle flap with omentum or bilateral pectoralis major flaps. Hospital records were reviewed for demographic pattern, time of presentation, symptoms on presentation, flap technique, postoperative success, hospital stay, mortality, morbidity, and bacteriology of the wounds. The patients operated from January 2006 to December 2010 were analysed. The follow-up ranged from 5 months to 3.5 years. The average age was 62.8 years. Male: female ratio was 20:5. Twenty-one patients were diabetics (84%).

Preoperative preparation

The laboratory studies done were as follows:

- Fluid collections for culture and analysis.
- Deep wound swabs, Sternal bone biopsies for aerobic, bacterial and fungal cultures.
- Complete blood count (CBC), blood cultures, C-reactive protein levels.

The imaging studies done were as follows:

- Plain X-ray chest (PA view).
- Computed tomography (CT) scan thorax for accurate detection of sternal disruption and/or destruction,

pockets of fluid, abscess, or pleural effusions, widening of mediastinum, pre or retrosternal air shadows. All these signs indicate mediastinitis.

Under general anaesthesia, with good muscle relaxation, the surgical procedures were carried out.

Surgical technique

The non-viable, necrotic bone and costal cartilages are debrided [Figures 1-2] and sternal wires removed. The margins of the sternum are debrided to reach healthy bone that bleeds.

At the end of thorough debridement, a VAC device is applied. The VAC system used is prepared from sterile foam, suction drain and ioban dressing (iodine incorporated sterile transparent adhesive dressing). Suction drain tube is connected to a gauge mounted wall suction at a pressure of 100 mm Hg. The VAC dressing is changed frequently depending upon the amount of discharge from the wound. Once a healthy granulating bed is achieved, the final flap closure is scheduled.

The sternal origin of pectoralis major is identified on either side of the tissue defect. It is released along the entire length of the body of sternum on both sides. Blunt dissection and diathermy are used to separate pectoralis muscle from skin, subcutaneous tissue and underlying pectoralis minor [Figure 3]. On both sides, the muscle flap is released inferiorly by dividing its attachments to the lower margin of the chest wall and the interdigitating fibres of external oblique abdominis muscle.

The fascia over the rectus may be harvested as extension of the pectoralis flap. This helps in filling the cavity in lower end of the defect, avoiding the need for separate flap like omentum or rectus abdominis muscle [Figure 9]. The superolateral limit of dissection of the flap is the anterior axillary fold. If the flap reaches comfortably across midline, the tendon of the pectoralis major is not divided from its humeral attachment. If more reach is needed, the humeral attachment of the pectoralis major is divided by taking a separate incision in axillary crease [Figure 4], and thus the pectoralis muscle is isolated on the thoracoacromial artery. Haemostasis is achieved at this stage.

The pectoralis major muscle flaps thus raised are swung across medially over the sternal defect and double breasted [Figures 5]. The dead space is thereby obliterated, and



Figure 1: Pre-debridement defect



Figure 2: Post-debridement defect



Figure 3: Isolated pectoralis major muscle flap

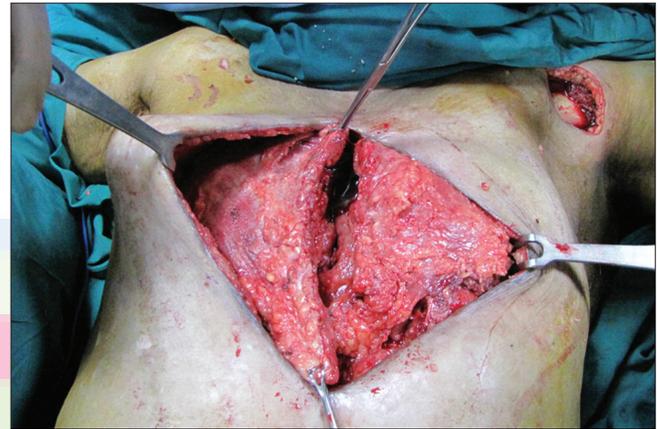


Figure 4: Mobilised bilateral pectoralis muscles with release of humeral head of the left side



Figure 5: Double breasting of pectoralis major muscle flaps



Figure 6: Post operative status

it also gives some amount of sternal stability. Multiple suction drains are placed both superficial and deep to the muscle flaps. The subcutaneous tissue and skin is closed [Figures 6,7 and 8].

Postoperative care

The suction drains are left *in situ* for at least 5 days, and patients receive antibiotic cover as per culture and sensitivity. If bone cultures are positive, then antibiotics



Figure 7: Preoperative photograph case 2



Figure 8: Postop photograph case 2



Figure 9: Mobilised pectoralis muscle with rectus sheath extension

are given for a minimum period of 6 weeks or till the C-reactive protein levels are within normal range. It is important that haematomas are avoided. Patients are advised against lifting heavy objects and contact sports

for at least 3 months. Physiotherapy is gradually initiated.

The mean operative time for flap surgery was 2 hours with single surgeon and two assistants. The average postoperative stay was of 12 days.

RESULTS

This study assessed the outcome of our experience with bilateral pectoralis major flaps with double breasting technique for the management of sternal dehiscence. Twenty-five patients with sternal dehiscence, eligible and operated for pectoralis major flaps, were studied in immediate and late postoperative period for a maximum follow-up period of 3.5 years. The details of the patients are given in Table 1.

The outcome was studied in the form of preoperative diabetic status, preoperative culture and sensitivity, intraoperative use of LIMA and/or RIMA, and postoperative range of movements at shoulder joints.

Twenty-three (92%) patients were discharged with complete wound closure. One patient (4%) had wound dehiscence after flap surgery. Out of 13 patients (52%) who had preoperative mediastinitis as per CT scan and wound culture reports, only one patient (4%) died in the hospital in the immediate postoperative period. No recurrent sternum infection has occurred till date in 24 patients (96%). For one patient (4%) who had wound dehiscence following flap surgery, daily dressings were done and wound healing was achieved with secondary intention. At follow-up, shoulder joint movements were normal in all the patients.

In our study of 25 cases, we have used bilateral pectoralis flaps in 23 patients. Out of these, rectus extension was used in 19 patients [Figure 9]. In these cases, need for separate flap for lower part of the defect was avoided. In two cases where lower end of the defect was very wide and deep, we have used unilateral pectoralis flap and omentum.^[13]

We observed that the most commonly involved microorganism in these patients was coagulase-negative *Staphylococci* (16%), followed by *Klebsiella pneumoniae* and *Candida albicans* (12%). Methicillin-resistant *S. aureus* and multiple organisms were isolated in 8% cases. Atypical mycobacteria were not found in any of these cases [Table 2]. Blood cultures were positive only in four cases which

included the patient with mediastinitis who died in the postoperative period.

No organisms were found in seven cases (28%), suggesting sterile wound dehiscence possibly due to devascularisation of sternum secondary to use of both mammary vessels to revascularise myocardium.

In this study, we observed the average time of coronary artery bypass graft (CABG) and time of presentation to be 79 days as the patients were referred late to plastic surgery unit. The average duration between time of presentation and pectoralis major flap with double breasting technique was 11 days. We have used VAC therapy as an intermediate measure between debridement and definitive flap cover to keep the wound sealed and prevent paradoxical movement of sternum. We have applied VAC to 20 of our patients, with an average time period of 11 days. The range was 3–33 days. The average time of hospitalisation after flap surgery was 11 days.

On follow-up, the patients were performing the activities of daily living comfortably using the hand from where pectoralis was isolated. There were no significant disabilities and the patients were satisfied with the outcome.

DISCUSSION

The development of life-threatening sternal wound infections after sternotomy for CABGs, valve replacement, heart transplantation, and other thoracic procedures has been a major concern for surgeons since the development of the median sternotomy approach over 40 years ago. These infections must be treated quickly and appropriately to avoid the development or progression of sternal osteomyelitis, mediastinitis, and systemic sepsis.

The principles of reconstruction include radical debridement and early tension free flap cover with vascular tissue. The dead space should be totally obliterated.

Over the past four decades, the treatment of sternal wound infections has evolved considerably.^[14-20] Debridement and immediate closure with muscle or myocutaneous flap has gained popularity since 1980s.^[21-27]

The very fact that there are various options described for the management of sternal dehiscence makes it obvious that the ideal option still eludes us. A combination of

flaps may be sometimes required, particularly to deal with difficult areas such as the inferior third of the sternum.^[28,29] Use of omentum involves laparotomy and opening of new cavity adjacent to area of infection.

Pectoralis muscle can be used as a turnover flap based on the secondary pedicles, isolated flap on thoracoacromial pedicle or as myocutaneous advancement flap.^[22,30] It is presently the favoured muscle flap for covering infected sternotomy wounds.^[31,32]

A major limitation of the pectoralis major flap has been coverage of the inferior third of the sternotomy wound.^[33,34] Studies have shown that the lower portion of wounds, near the xiphisternum, is the most common site of dehiscence after flap repair.^[35] Tripedicle pectoralis major myocutaneous flap has been used by some authors to address this problem.^[36]

Unlike the transposition or rotation technique of muscle flaps,^[37] the technique of advancement of the pectoralis major bilaterally is efficient in obliterating dead space and covering the entire defect with tension-free vascular tissue. There are several classifications of sternal infection; we prefer the classification reported by Jones.^[38]

In our experience, early diagnosis and intervention contributes significantly to reduce the extent of tissue necrosis. This opinion is shared by other authors.^[39,40] In the last 10 years, use of the pectoralis major muscle has contributed to decrease in the 30-day operative mortality rate of about 7.9–9.5% and zero 30-day hospital mortality as reported by some authors.^[41] The duration of hospital stay and mortality are more when patients are referred late to plastic surgery units.^[39]

In our series, in 23 out of 25 cases, both left and right mammary vessels were used, so rectus abdominis or turnover pectoralis major flap was not an option. We have used omentum in two of our cases to fill the cavity in lower half of the wound.^[13] In most of the cases, we have found that rectus sheath extension of pectoralis muscle suffices to fill lower end dead space. Thus, this avoids the need for other flap for lower part of the wound. We chose to cover the defect with the bilateral pectoralis muscle flaps, one of which is isolated on the thoracoacromial pedicle. Isolation of muscle increases its reach across the midline and inferiorly. The technique of double breasting used by us in all our cases has the following advantages:

Table 1: Clinical details of the patients

Age	Sex	DM	Date of CABG	Date of presentation	Time bet CABG and presentation (in days)	Type of dehisce	Pus c/s	Date of flap sx	Time bet presentaion and flap sx (in days)
65	M	Y	1/1/2005	8/5/2005	159	2B	COAG –ve staph.	13/05/2005	5
61	M	Y	8/4/2005	28/05/2005	50	3A	MRSA	13/06/2005	16
66	M	Y	22/04/2005	7/5/2005	15	3A	Enteobact.+ COAG. –ve st.	13/06/2005	37
62	M	Y	19/12/2005	25/01/2006	37	3A	E coli+psudomonas aerugino	27/01/2006	2
35	M	N	1/9/2006	15/03/2007	227	2B	No growth	23/03/2007	8
69	M	Y	9/7/2007	24/03/2008	259	3B	Candida albicans	25/03/2008	1
58	F	Y	8/12/2007	20/03/2008	102	2B	Staph. aureus	23/03/2008	3
66	M	N	2/4/2008	22/04/2008	20	2B	No growth	22/04/2008	0
63	M	Y	29/05/2008	21/07/2008	69	2B	No growth	21/07/2008	0
66	M	Y	4/12/2008	4/1/2008	30	3A	E coli	29/12/2008	25
56	M	Y	17/02/2009	28/03/2009	39	3B	No growth	28/03/2009	0
63	F	Y	13/03/2009	22/04/2009	40	2B	No growth	23/04/2009	1
60	F	Y	10/7/2009	6/5/2010	243	2B	MRSA	17/05/2010	17
68	F	Y	30/07/2009	8/8/2009	9	3B	Psudomonas aeruginosa	18/08/2009	10
61	F	Y	1/8/2009	26/08/2009	25	2A	Enterococcus feacalis	29/08/2009	3
68	M	N	25/08/2009	28/09/2009	34	2B	Klebsiela pneumoniae	7/10/2009	11
62	M	Y	25/08/2009	7/10/2009	45	2B	No growth	16/10/2009	9
71	M	Y	26/12/2009	18/01/2010	23	2B	Candida albicans	4/2/2010	18
67	M	Y	18/05/2010	24/08/2010	98	2B	No growth	25/09/2010	31
68	M	N	29/05/2010	30/07/2010	62	3A	COAG –ve staph.	5/7/2010	35
56	M	Y	29/06/2010	17/10/2010	110	3A	Candida albicans	23/10/2010	6
76	M	Y	15/07/2010	17/08/2010	33	3A	COAG –ve staph.	2/9/2010	16
65	M	Y	3/8/2010	21/09/2010	49	2B	COAG –ve staph.	29/09/2010	9
53	M	Y	3/8/2010	22/12/2010	141	2B	Klebsiela pneumoniae	3/1/2011	12
65	M	Y	24/08/2010	29/11/2010	66	3B	Klebsiela pneumoniae	18/12/2010	21

CABG: coronary artery bypass graft, MRSA: Methicillin-Resistant *Staphylococcus aureus*

Table 1 (contd...)

1. The double breasting gives some stability to the sternum and prevents paradoxical movements of the sternum.
2. It obliterates the cavity and helps in prevention of haematoma/seroma.
3. By using the double breasting technique, overlapping suture lines are avoided. Even if there is dehiscence of one suture line, the other suture line acts as a protective barrier and prevents complete disruption.

In addition to other advantages, this procedure can be used in patients who underwent CABG using both internal thoracic arteries.^[40,41] In most of the patients, both the mammary arteries were used for revascularisation. The debridement of sternum was significant in these cases. We have not done rewiring in any of our cases as it was not feasible. Double breasting took care of the skeletal stability satisfactorily.

The use of mediastinal drainage under high vacuum pressure with polyurethane foam have been promising in

the treatment of primary sternal infection after median sternotomy.^[42] This procedure was considered effective according to a multicenter study.^[43] However, this procedure can only be used in patients with intact pleura and it is not free from complications such as pleural rupture and fall of cardiac output.^[44] In our study, VAC drain was useful to narrow the gap between debridement and flap surgery.

Risk factors for sternal dehiscence in our series were use of internal mammary arteries, diabetes and infection. In 7 (28%) patients, it was the problem of nonviability of sternum as the cultures were negative in these patients. Infection was mainly due to gram-negative pathogens as compared to the usual *S. aureus*.

CONCLUSIONS

In the sternal wound infection involving deep planes or with post-sternotomy dehiscence, we suggest radical

Table 1 (contd...)

Age	Type of flap	LIMA AND RIMA used	Date of discharge	Time b/w flap surg to discharge (in days)	Outcome	Shoulder jt. Movements
65	Bilat. Pect. Major	Y +AVR DONE	23/05/2005	10	Good	Normal
61	Bilat. Pect. Major	N	27/06/2005	14	Good	Normal
66	Bilat. Pect. Major with rect	Y	16/06/2005	3	Good	Normal
62	Bilat. Pect. Major with rect	Y	15/03/2006	48	Good	Normal
35	Bilat. Pect. Major with rect	Y	26/03/2007	3	Good	Normal
69	Bilat. Pect. Major with rect	Y	31/03/2008	6	Good	Normal
58	Bilat. Pect. Major with rect	Y	2/4/2008	10	Good	Normal
66	Bilat. Pect. Major with rect	Y	26/04/2008	4	Good	Normal
63	Bilat. Pect. Major with rect	Y	25/07/2008	4	Good	Normal
66	Unilat. Pect. Major+oment	Y	19/01/2008	22	Good	Normal
56	Unilat. Pect. Major+oment	Y	5/5/2009	38	Good	Normal
63	Bilat. Pect. Major with rect	Y	5/5/2009	12	Good	Normal
60	Bilat. Pect. Major with rect	Y	22/05/2010	5	Good	Normal
68	Bilat. Pect. Major with rect	Y	Death	-	Poor	-
61	Bilat. Pect. Major	Y	4/9/2009	6	Good	Normal
68	Bilat. Pect. Major with rect	Y	20/10/2009	13	Good	Normal
62	Bilat. Pect. Major with rect	Y	24/10/2009	8	Good	Normal
71	Bilat. Pect. Major with rect	Y	11/2/2010	7	Good	Normal
67	Bilat. Pect. Major with rect	Y	2/10/2010	8	Good	Normal
68	Bilat. Pect. Major with rect	Y	14/07/2010	9	Good	Normal
56	Bilat. Pect. Major with rect	Y	30/10/2010	7	Good	Normal
76	Bilat. Pect. Major with rect	Y	24/09/2010	22	Good	Normal
65	Bilat. Pect. Major with rect	Y	13/10/2010	15	Good	Normal
53	Bilat. Pect. Major	N	17/01/2011	14	Good	Normal
65	Bilat. Pect. Major with rect	Y	21/12/2010	3	Wd dehisc	Normal

Table 2: Percentage of microorganisms found in culture and sensitivity

Microorganism	No. of patients	Percentage
Coagulase negative <i>Staphylococci</i>	4	16
<i>Klebsiella pneumoniae</i>	3	12
<i>Candida albicans</i>	3	12
Methicillin-Resistant <i>Staphylococcus aureus</i>	2	8
<i>Escherichia coli</i>	1	4
<i>Pseudomonas aeruginosa</i>	1	4
<i>Staphylococci aureus</i>	1	4
<i>Enterococcus faecalis</i>	1	4
Multiple organisms	2	8
No organisms	7	28

debridement of non-viable tissues, especially when both mammary arteries are used as in our series. It should be followed by early flap cover. We recommend using bilateral pectoralis major flaps with rectus extension on one side and double breasting them across the midline. The rectus sheath extension helps to fill lower end of the defect, eliminating the need for omentum in most of the cases. Releasing the pectoralis muscle from its insertion and

isolating it on thoracoacromial pedicle helps in increasing its reach both across the midline and inferiorly. In our series, the option of using rectus muscle was not available as in majority of the cases both the mammary arteries were used during bypass surgery. This technique is efficient in obliterating the dead space with vascular tissue, and it fulfills most of the criteria of ideal flap and avoids the need for second flap for lower part of the wound. It reduces the morbidity and mortality and assists in early recovery.

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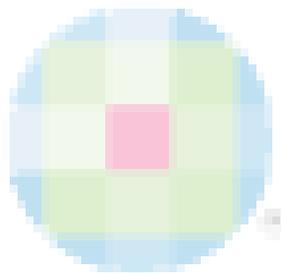
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Sahasrabudhe, *et al.*: Pectoralis major muscle flap for sternal dehiscence

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