The internal mammary artery perforator flap and its subtypes in the reconstruction of median sternotomy wounds

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ABSTRACT

Objective: To determine the feasibility of using the internal mammary artery perforator (IMAP) flap for superficial and deep sternal wound breakdowns.

Methods: This was a retrospective case review of 9 patients with sternal wound dehiscence over an 18-month period between 2013 and 2015. Seven of the 9 patients received a single IMAP flap to cover full-length sternal wounds, including 4 with a fasciocutaneous flap and 3 with a musculocutaneous flap.

Results: All of the patients were male, with a mean age of 68 years. The mean number of perforators was 1.3, with a mean perforator diameter of 1.5 mm. In all cases, the torsion angle was 80 degrees, with a translational pedicle movement of 1 to 2 cm. There were no instances of total flap failure and only 2 cases of partial flap necrosis, which were managed conservatively. One flap, performed when both internal mammary arteries had been harvested previously, showed complete survival.

Conclusions: The IMAP flap has an advantage in its the ability to reconstruct the entire length of a sternotomy wound from the suprasternal notch to the xiphisternum with relatively minimal dissection and morbidity compared with more conventional flaps such as pectoralis major, rectus, and omental flaps. Nevertheless, caveats for its use remain, such as in patients with vasopressor therapy and the resulting subclavicular scar, which is unaesthetic in women. Overall, the IMAP flap is an attractive reconstructive tool specifically in stable male patients with noninfected sternotomy wound dehiscence with a defect width of up to 7 cm. In this patient subset, it is the ideal first-line reconstructive tool. (J Thorac Cardiovasc Surg 2016;■:1-5)

IMAP flap reconstruction for sternal wounds.

Central Message

The IMAP flap is a niche flap with specific indications in sternal wound reconstruction and, when appropriate, provides a relatively simple solution to a complex problem.

Perspective

IMAP flap reconstruction will mark a drastic change in how sternal wounds are approached.

ACQ

Sternotomy wound breakdown following cardiac surgery is an uncommon but serious event that can leave significant defects, often exposing the mediastinum.[1] A common cause is wound infection, but occasionally mechanical dehiscence of the skin can occur, particularly in conditions involving increased chest wall excursion (eg, patient struggling to breathe). The standard first line of management is surgical debridement, followed by the removal of sternal wires, if necessary. Once the wound is clean, topical negative pressure therapy is applied until definitive closure is achieved.

At this stage, tissue must be imported into the wound in the form of a flap to achieve wound healing. Conventional reconstructive flaps used in sternal reconstruction, including pectoralis major, rectus, and omental flaps,[2] either do not cover the entire length of the defect or, as in the case of the omental flap, necessitate laparotomy.

Although useful for closing voluminous defects, each single flap does not have the capacity to resurface the entire length of the sternal defect, and flaps must be used in tandem to close these wounds, as evidenced by the anatomic classifications of sternal defects aligned closely with muscle flap selection.[3] Moreover, sacrificing these muscles can cause functional disability, potential hernias (in the case

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Abbreviations and Acronyms

ASA	= American Society of Anesthesiologists
CABG	= coronary artery bypass grafting
CT	= computed tomography
DSEP	= deep superior epigastric perforator
fc-IMAP	= fasciocutaneous IMAP
IMA	= internal mammary artery
IMAP	= internal mammary artery perforator
LTAP	= lateral thoracic artery perforator
mc-IMAP	= musculocutaneous IMAP

of the rectus muscle), seromas, and other problems. In addition, such extensive chest muscle dissection at that depth can restrict chest excursions in the postoperative period due to pain.

Other treatment options include the use of topical negative pressure therapy[4] to eventually close these wounds; however, closure takes a long time, with the potential for infection. More recently, the deep superior epigastric perforator (DSEP) flap has been described for sternal wound closure.[5,6] This fasciocutaneous perforator flap, based on the single perforator of the DSEP, pivoted through 90 degrees, has the capability of successfully resurfacing large defects. Reported advantages include relatively less dissection, muscle function preservation, and potentially a hidden submammary scar in women. However, use of the DSEP flap requires an intact internal mammary artery (IMA) axis, is limited by the potential length that can be harvested, and, if a deeper mediastinal defect is to be reconstructed, the lack of additional muscle beneath the DSEP flap that can be included as a composite muscle-fasciocutaneous flap for filling dead space.

Here we describe the use of the internal mammary artery perforator (IMAP) flap in a spectrum of presternal and mediastinal defects as an alternative form of reconstruction in selected cases. Its major advantage is that a single fasciocutaneous or musculocutaneous IMAP flap can cover any 3-dimensional sternotomy wound defect.

PATIENTS AND METHODS

In a retrospective case series over an 18-month period between 2013 and 2015, a total of 9 patients requiring midline chest reconstruction were referred, of which 7 had an IMAP flap. The remaining 2 patients included 1 patient with a pectoralis major muscle advancement flap and 1 patient who received topical negative pressure therapy. All 9 patients were referred from the cardiothoracic surgical unit at the Queen Elizabeth Hospital following wound breakdown after cardiothoracic surgery.

All patients were assessed initially for suitability for the IMAP flap using a hand-held 8- MHz Doppler probe (Huntleigh, Cardiff, United Kingdom). Preoperative perforator selection in terms of size and site was confirmed using computed tomography (CT) angiography, where appropriate. In 1 patient, CT angiography was not performed because both internal mammary arteries were previously harvested for coronary bypass procedures.

The 9 patients in this cohort included 7 males and 2 females, with a mean age of 50 years (range, 30 to 75 years). The most common comorbidities were hypertension, diabetes, ischemic heart disease, and immunosuppression (in the transplant recipients). One patient suffered from cystic fibrosis and had undergone heart-lung transplantation. Overall premorbid status was reflected in the American Society of Anesthesiologists (ASA) grade; 3 patients were ASA grade 2, 4 patients were ASA grade 3, and 2 patients were ASA grade 4. In this cohort, premorbid status was then weighted as part of the decision making process, with the following exclusion criteria: (1) receipt of vasopressors or at high probability of receiving vasopressors postoperatively, particularly in patients who were already septic; (2) ongoing local infection (eg, osteomyelitis even after multiple debridements); and (3) ASA grade of $\geq$4.

Two of the 9 patients were excluded, 1 who was already on vasopressors and thus received a pectoralis major muscle advancement flap, and 1 who had poor wound healing due to a persistent infection, which ruled out the IMAP flap as a reconstructive option. This patient was left to heal secondarily with the aid of topical negative pressure therapy. Both of these patients had an ASA grade of 4.

Surgical Technique

Based on the CT angiogram, the most optimal IMA perforator, usually the second but occasionally the first or third, is identified with the Doppler probe preoperatively and marked. Next, the lateral thoracic artery perforator (LTAP) is marked, and the IMAP-LTAP axis is drawn out. The fasciocutaneous IMAP (fc-IMAP) flap is raised subfascially up to the mid-axillary line. If required, axillary lymph nodes can be included within the flap as a chimeric-in-parallel component, to reduce the risk of lymphoedema and a subsequent "pin-cushioning" effect within the propeller flap. The maximum length of the flap can be up to 25 cm, and provided that the width of IMAP flap is kept below 7 cm, the secondary defect can be closed primarily. If possible, superficial veins at the pivot point are preserved to maximize venous outflow.

For deeper mediastinal defects, a musculocutaneous IMAP (mc-IMAP) flap can be raised with the underlying pectoralis major muscle for additional bulk and volume filling. Use of an mc-IMAP flap also provides a longer vertical length of the IMA perforator to be included within the composite flap, as well as an increased perforator diameter as the pivot point is closed to the internal mammary vessels. For additional perfusion, a 1-cm cuff of pectoralis muscle is preserved around the fc-IMAP; this modification has been found to augment flap perfusion and increase its dimensions.

Postoperatively, the patient is kept ventilated overnight in the intensive care unit, with a reduced chest wall ventilatory pattern maintained by a cardiac anesthesist. Flap observations are continued hourly for the first 24 hours and every 2 hours on the second postoperative day. Chest physiotherapy is instituted after 48 hours. After 5 days, the patient is given chest wall splints and discharged to home.

RESULTS

Of the 7 patients who received an IMAP flap, 4 had an fc-IMAP flap and 3 had an mc-IMAP flap. All 7 patients were male, with a mean age of 68 years (range, 44 to 79 years). The average defect size was 21 $\times$ 5 cm. All of these defects encompassed the full length of the sternum, with the fc-IMAP flap used for presternal defects and the mc-IMAP flap used for deeper mediastinal wounds. The mean number of perforators within the IMAP flap was 1.3, with a mean perforating vessel diameter of 1.5 mm. Because the IMAP flap was designed along the IMAP–LTAP axis, the angle of torsion was 80 degrees in these patients.

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