The rectus abdominis muscle advancement flap as a salvage option for chest wall reconstruction

NM Pantelides, SS Young, S Iyer

Department of Plastic and Reconstructive Surgery, Royal Preston Hospital, Lancashire Teaching Hospitals NHS Foundation Trust, Preston, UK

ABSTRACT

We describe a previously unreported technique of advancing the rectus abdominis muscle superiorly, based on the deep inferior epigastric artery, to cover a lower anterior chest wall defect. This technique represents an important salvage option for chest wall reconstruction and affords a great deal of intra-operative flexibility.

KEYWORDS

Rectus abdominis muscle – RAM – VRAM – Chest wall reconstruction

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CORRESPONDENCE TO

Nicholas Pantelides, E: nmpantelides@gmail.com

Introduction

The rectus abdominis muscle is a robust and versatile muscle, which is used in a variety of different configurations for microsurgical reconstruction. For chest wall defects, it is typically used as a pedicled flap based on the superior epigastric artery (SEA), commonly with a vertical skin paddle (VRAM flap). We describe a previously unreported technique of advancing the rectus abdominis muscle superiorly, based on the deep inferior epigastric pedicle, to cover an inferior chest wall defect.

Case history

A 57-year-old man underwent resection of a large grade III chondrosarcoma arising from his sternum. The excision necessitated resection of the lower two-thirds of the sternum, together with the adjoining anterior part of the third to seventh ribs and the eighth to tenth costochondral junctions. The anterior pericardium and a section of the right lung were also removed. Both internal mammary arteries had to be sacrificed.

A bovine pericardial patch and a two-layer mesh and bone cement sandwich were used to restore the integrity of the chest wall. Minimal skin was lost due to the endophytic nature of the tumour but the reconstruction required robust muscle cover. Bilateral pectoralis major flaps were advanced medially for superior coverage but a sizeable inferior defect remained, 12cm in transverse diameter and 10 cm longitudinally.

As both internal mammary arteries had been sacrificed, the initial plan was to reconstruct the defect using a pedicled right rectus abdominis muscle flap, based on the eighth

intercostal artery perforator. Beginning superiorly, the flap was raised in the standard fashion and the perforator was identified. A microvascular clamp was applied to the deep inferior epigastric artery to ensure adequacy of the blood supply, but the eighth intercostal artery perforator was found to be insufficient to supply the flap alone (Fig 1). Instead, the reconstruction was salvaged by advancing the rectus abdominis muscle superiorly, based on the robust deep inferior epigastric artery. The chest incision was extended to the abdomen and the muscle was dissected free and detached

Figure 1 The right rectus abdominis muscle with isolation of the eighth intercostal artery and deep inferior epigastric artery (DIEA) pedicle. The divided superior epigastric artery (SEA) pedicle is also visible.

from the pubic symphysis, leaving it attached only by the skeletonised deep inferior epigastric pedicle, which was dissected to its origin. The eighth intercostal artery perforator was divided and the muscle was advanced superiorly by 12cm (Fig 2) and double breasted under the pectoralis major muscles. There was, in fact, scope to advance the muscle further had this been necessary. The remaining chest wall skin was closed directly over the flap reconstruction. The abdomen was closed in layers: the anterior rectus sheath was directly apposed over the advanced rectus abdominis muscle flap and reinforced with an inlay mesh prior to skin closure.

The patient recovered well and was discharged home on the seventh day postoperatively. There were no wound healing problems. The reconstruction gave a good cosmetic outcome with no abdominal bulging or herniation (Fig 3).

Discussion

Chest wall defects represent a reconstructive challenge and require a detailed knowledge of the anatomy and physiology of the chest. The pectoralis major, latissimus dorsi and pedicled rectus abdominis muscle flaps are considered the 'workhorse flaps' and several authors have proposed algorithms for chest wall reconstruction.^{1,2} Given the complexity and diversity of the defects, however, these algorithms are difficult to follow and it is often necessary to alter the plan intraoperatively.

The rectus abdominis muscle is a type III muscle, supplied by two pedicles: the superior epigastric and the deep inferior epigastric arteries. Of these, the deep inferior

Figure 3 Appearance five months postoperatively, demonstrating a good abdominal contour.

epigastric artery is the dominant pedicle. It arises from the external iliac artery and passes into the rectus abdominis laterally at the border of the lower third and upper two-thirds. It typically divides into a medial and lateral branch before anastomosing with the superior epigastric artery, a terminal branch of the internal mammary artery, through a choke zone periumbilically.

The muscle is highly versatile and can be incorporated into a number of different flaps for chest wall reconstruction. It contributes significant bulk and is most useful for large anterior or anterolateral defects. Flaps are typically superiorly based and can be raised as muscle only or musculocutaneous (rectus abdominis myocutaneous, RAM) flaps, with the skin paddle designed either transversely (TRAM) or vertically (VRAM). Where the internal mammary arteries are not available, Fernando *et al.* reported that a musculocutaneous flap can be based solely on the eighth intercostal perforator.⁵

Our technique represents an important salvage option for chest wall reconstruction. It is particularly relevant when the patency of the superior epigastric artery and the reliability of the eighth intercostal perforator are uncertain at the beginning of the operation. A RAM/VRAM flap can be partially raised at the same time as tumour excision with isolation of the superior epigastric, eighth intercostal and deep inferior epigastric pedicles. These can then be sequentially occluded with a microvascular clamp. If the deep inferior epigastric artery is the only viable pedicle, the vessels can be dissected out to their origin and the flap advanced superiorly. There is no need to turn the patient, thus allowing a great deal of intraoperative flexibility.

We advanced muscle only, as the skin sacrifice was minimal, but this advancement can be done with a skin paddle. It is best suited to lower anterior chest wall defects, where it can contribute a significant volume of local tissue, with similar texture and appearance. It spares the morbidity of an omental flap harvest and provides coverage beyond the reach of pedicled pectoralis major or unilateral latissimus dorsi flaps. It also avoids the prolonged operative time of free tissue transfer. While it does not afford the same reach

Figure 2 The rectus abdominis muscle was advanced 12cm superiorly. The arrow demonstrates the lower border of the skeletal reconstruction, at the level of the resected xiphisternum.

superiorly as a VRAM pedicled on the superior epigastric artery, the pedicle length is considerable. The flap tip can reach the junction of the upper third and lower two-thirds of the sternum but would need to be combined with another flap reconstruction for defects that extend right to the superior aspect of the chest.

Conclusions

We describe the superior advancement of a rectus abdominis muscle flap for chest wall reconstruction, based on the deep inferior epigastric pedicle. This is an excellent salvage option and affords a great deal of intraoperative flexibility.

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