

Sagittal split tibialis anterior muscle flap.

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Sternal wound closure using the rectus abdominis muscle in spite of a subcostal scar

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Summary Although median sternotomy wound complications are uncommon, the consequences can be potentially devastating. The superior-based rectus abdominis muscle is an important complementary flap that is especially valuable to obliterate the inferior aspect of these extensive wounds. This is not usually possible with the workhorse pectoralis major muscle alone. The increasing use of the internal mammary arteries as a bypass conduit or a prior subcostal scar may devascularize the rectus abdominis muscle and, thus, are relative contraindications for selecting this muscle. However, depending on the size of the defect and location of the subcostal scar, the upper portion of the rectus abdominis muscle may, at least, still be a viable and important alternative flap.

Keywords Rectus abdominis muscle · Sternal wound · Infection

Introduction

Complications after median sternotomy invariably occur in the most compromised host who can least afford further surgical intervention. The extent of any treatment plan depends on the severity and depth of the wound involved, and, according to Arnold and Pairolero [2, 11], a fulminant mediastinitis or chronic insidious wound is a mandatory indication for using vascularized tissues. Muscle flaps, in particular, not only obliterate the dead space but enhance the immunological milieu and improve expectations for salvage [1].

Due to its proximity and large surface area, the pectoralis major muscle has had a dominant role in closing ex-

tensive sternal defects [8, 9, 11, 12, 14]. Even when bilateral pectoralis flaps or the latissimus dorsi muscle [16, 19] are used, the lower third of the wound over the anterior diaphragm is often tenuously covered, if at all [4, 16, 17]. Alternative solitary flaps that are available for filling the entire wound include the omentum [3, 8, 15] or even free flaps [16], but all have an inherent complexity and limitations.

The rectus abdominis muscle is another simple local option and is especially useful as an adjunct to fill only the xiphoid area [5, 6, 12, 14], although a deepithelialized vertical rectus abdominis musculocutaneous flap by itself can reach the manubrial area [6]. Unfortunately, the increased use of unilateral or even bilateral internal mammary arteries as a bypass conduit has limited the usefulness of the superior-based rectus muscle, even though it might survive through collaterals [5, 10, 13] via the costomarginal branch of the superior epigastric artery [18]. Another contraindication for using the rectus muscle has been a Kocher or subcostal incision, usually due to a prior cholecystectomy [14, 16]. However, in unusual circumstances, the upper portion of this muscle could still be a viable option to, at least, obliterate the inferior aspect of the median sternotomy wound.

Materials and methods

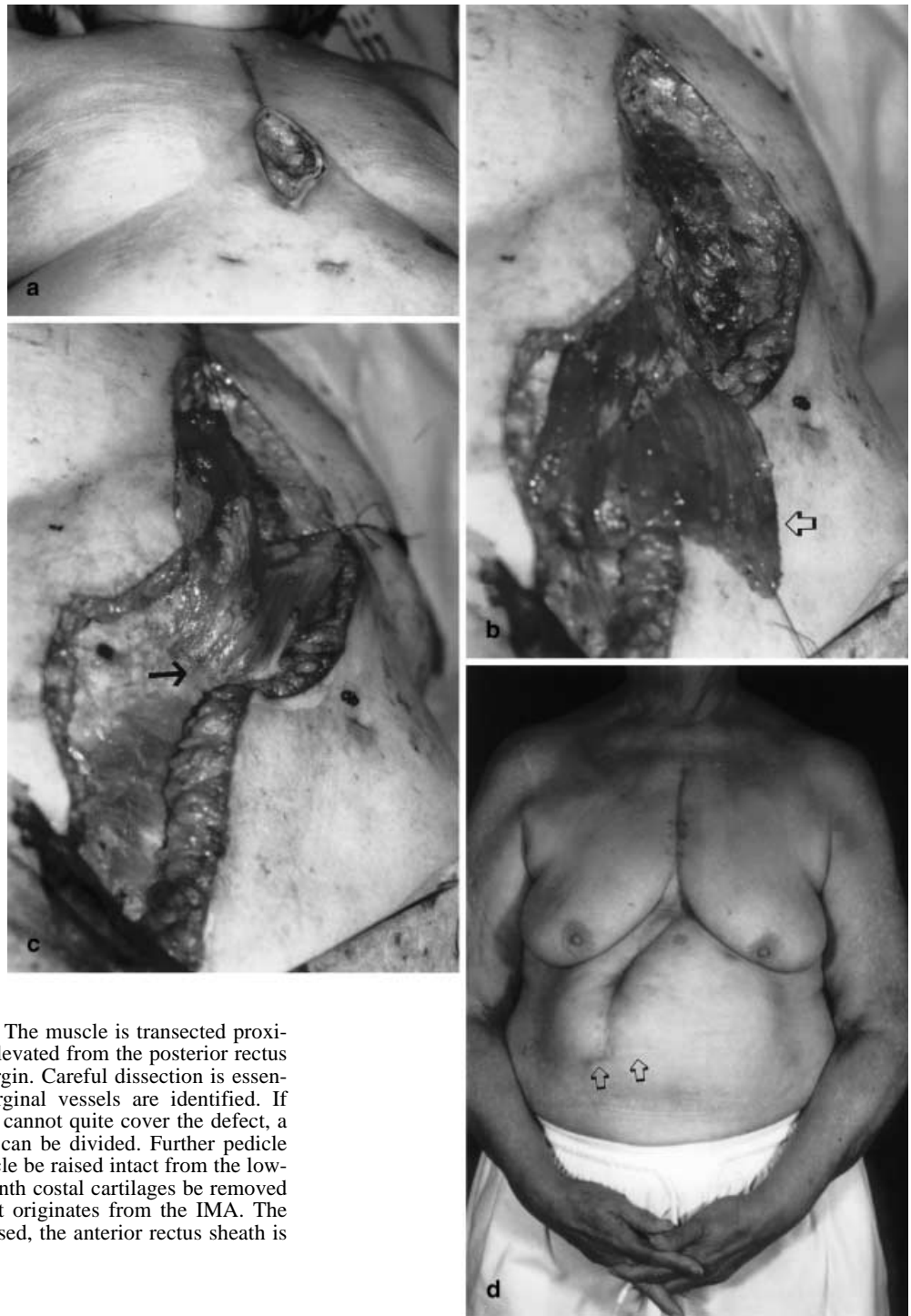
Assuming that the ipsilateral internal mammary artery (IMA) has not been violated or that the risk of depending on collateral circulation is acceptable, the superior-based rectus abdominis muscle can potentially be used as a small local turnover flap even in the presence of a subcostal scar. The distance from the most superior aspect of the xiphoid defect to the estimated location of the superior epigastric (SEA) pedicle at the costal margin would then be the needed length of the rectus muscle. The distance from that pedicle to the subcostal scar inferiorly will be the available length of the rectus muscle. If the needed length is less than the available length, then this flap could be used.

A paramedian incision curving from the distal end of the median sternotomy wound will allow the anterior rectus sheath to be centrally divided and the medial and lateral edges of the rectus muscle to be identified [14, 15]. The inferior flap dissection must cease at the site of the scar in the muscle since any neovascular-

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Fig. 1 **a** Soft tissue necrosis involving only the inferior aspect of the median sternotomy incision. **b** Using a paramedian approach, part of the right rectus abdominis muscle (*arrow*) was elevated above the subcostal scar. **c** When turned over, it was long enough to completely cover the exposed bone (*arrow* superior epigastric vessels). **d** The totally healed wound 3 months later; note that the right paramedian scar ends perpendicular to the old subcostal scar (*arrows*)



ization distal to that is unreliable. The muscle is transected proximal to the scar, and it is rapidly elevated from the posterior rectus sheath up to the lateral costal margin. Careful dissection is essential until the SEA and costomarginal vessels are identified. If when turned over the muscle still cannot quite cover the defect, a diminutive costomarginal branch can be divided. Further pedicle lengthening requires that the muscle be raised intact from the lower ribs and that the sixth and seventh costal cartilages be removed to lengthen the SEA pedicle as it originates from the IMA. The rectus muscle flap is then transposed, the anterior rectus sheath is repaired, and the chest is closed.

Case reports

Case 1: solitary flap

A 70-year-old obese, diabetic female was readmitted 6 weeks after multiple coronary artery bypass grafts (CABG) in which the left IMA had been used as a conduit because of skin necrosis of her distal median sternotomy scar (Fig. 1). There was sternal non-union, but all bone bled on débridement. Otherwise, this was primarily a problem of local soft tissue necrosis, with minimal bone exposure. Fortunately, her right subcostal scar had descended caudally so that the distance from her right costal margin at the level of the xiphoid to the uppermost aspect of the defect was less than

the distance from the rib margin to the cholecystectomy scar. The upper right rectus abdominis muscle was elevated as described earlier. The costomarginal branch was divided to release the flap so it could be turned over to fill the entire lower chest defect. The adjacent chest skin could be advanced to cover the muscle.

There was no evidence of reinfection at the 1 year follow-up.

Case 2: complementary flap

A thin 70-year-old diabetic female developed a suppurative mediastinitis with extensive tissue necrosis that required radical sternal

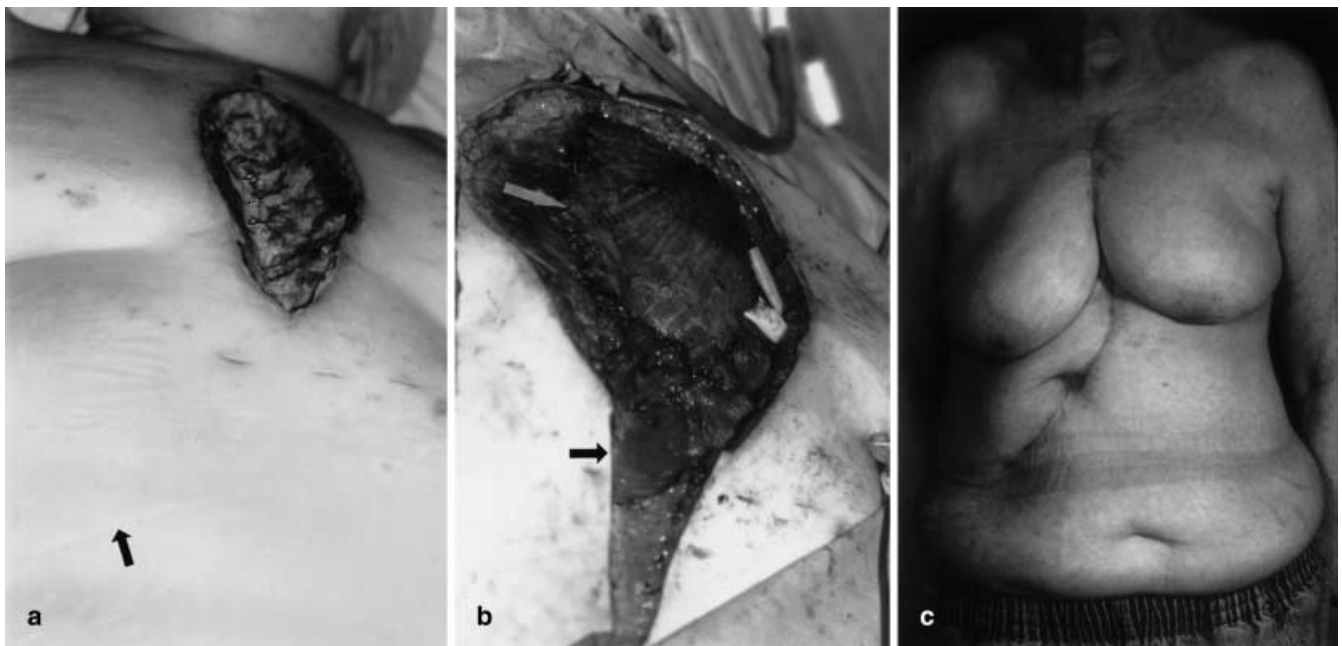


Fig. 2 **a** Open median sternotomy wound with widespread tissue necrosis; note the pre-existing right subcostal scar (*arrow*). **b** Following débridement, only the upper three-quarters of the anterior mediastinum could be covered by the left pectoralis major muscle (*white arrow*). The lower quarter was covered using the superiorly pedicled portion of the right rectus abdominis muscle (*black arrow*) found viable above the subcostal scar. **c** The wound healed without sequelae

and soft tissue débridement including a portion of the posterior rectus sheath inferiorly 1 month after repeated CABG. The upper three-quarters of the anterior mediastinum were easily covered with a left pectoralis major muscle advancement flap. To obliterate the xiphoid region and protect the peritoneal repair, a rectus abdominis muscle flap was considered. Unfortunately, the left IMA had been used as a conduit and she had a right subcostal scar (Fig. 2). However, this was well below the costal margin so a superior-based right rectus abdominis muscle flap was raised proximal to the scar. After the muscle was somewhat elevated from the lower ribs, it could reach the defect without lengthening the SEA pedicle.

She healed uneventfully.

Results

The right superior-based rectus abdominis muscle flap with an intact ipsilateral IMA has been used on two occasions despite the fact that both patients had subcostal scars from prior cholecystectomies. In both cases the muscle was viable only to the level of the subcostal scar. Although only a portion of the muscle could be utilized, wound closure was successful in both cases.

Discussion

The superior-based rectus abdominis muscle can be a valuable local flap for small defects in the epigastric region or as an adjunct to close the inferior portion of an extensive median sternotomy wound [5, 6, 12, 14]. Un-

fortunately, prior use of the IMA or the presence of a subcostal scar are normally contraindications for its use [5, 10, 13, 14, 16]. If bone is not exposed, local skin flaps by themselves might work [13]. Other more complicated alternatives are a segmental pectoralis major muscle flap based on internal mammary perforators [4, 12], bipedicled combined pectoralis major and inferior-based rectus abdominis flap [16, 17], omentum [3, 8], or a free flap [16].

The ability to use the rectus abdominis muscle in spite of an ipsilateral subcostal scar is an attractive, simpler concept. This, though, requires that the original Kocher incision was placed distally enough or that the scar has migrated inferiorly with time, so that there is sufficient length of rectus muscle available. Although only the upper portion of the anterior rectus sheath is violated because the useable muscle is above the subcostal scar, all the risks of this donor site still exist [7, 15, 16]. The availability of a rectus abdominis muscle flap in spite of an ipsilateral subcostal scar should be remembered and its use considered, if necessary.

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G.G. HALLOCK