Internal mammary artery pedicle: a solution for prophylactic flap coverage in high-risk trans-sternal thoracic surgery

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Abstract
Prophylactic use of vascularized flaps to buttress and reinforce bronchial or oesophageal closure is nowadays the preferred approach in high-risk cases, especially for extended resections with tracheobronchial reconstructions or after neoadjuvant chemoradiotherapy. However, the majority of these options and techniques are described for an approach through a thoracotomy. Due to anatomical restrictions, these options are less suitable when a trans-sternal approach is used. We emphasize the use of an internal mammary artery pedicle as prophylactic flap coverage in 3 high-risk cases, all operated on through a median sternotomy.

Keywords: Lung cancer • Surgical therapy • Lung—other • Oesophagus—other

BACKGROUND
Prophylactic use of vascularized flaps to buttress and reinforce bronchial or oesophageal closure is nowadays the preferred approach in high-risk cases, especially for extended resections with tracheobronchial reconstructions or after neoadjuvant chemoradiotherapy. The most common techniques include the use of intercostal muscle flaps, pedicled pericardial fat pads and mediastinal tissue, and to a lesser extent, parietal pleural flaps, diaphragmatic flaps, omentum, latissimus dorsi and serratus anterior muscle flaps [1].

The majority of these techniques are described for an approach through a thoracotomy. However, due to anatomical restrictions, these options are less suitable when a trans-sternal approach is used. We emphasize the use of an internal mammary artery (IMA) pedicle as prophylactic flap coverage in 3 high-risk cases, all operated on through a median sternotomy.

CASE 1
A 59-year-old man was referred to our tertiary referral centre with a bronchoesophageal fistula. His medical history included laparoscopic cholecystectomy, umbilical hernia repair and a presumably congenital stenosis of the left main bronchus, which was treated with bronchial stenting. One year after the initial procedure, the patient was admitted with bilateral aspiration pneumonia, with coughing on liquid ingestion. Oesophagoscopy and bronchoscopy demonstrated a perforation of the stent through the membranous portion of the left main bronchus in the oesophagus. An oesophageal WallFlex stent (Boston Scientific, 23 × 10.5 mm) was placed for short-term palliation. He was transferred to our centre for surgical repair of the bronchoesophageal fistula.

In the operating room, the oesophageal stent was removed through oesophagoscopy. The median sternotomy was performed, and the left IMA was harvested as a broad pedicled graft (Fig. 1). An omental flap was deemed unfavourable due to the patient’s cachexia and previous abdominal surgery. The left main bronchus was transected just distal to its origin from the main carina, and the bronchial stent was removed. A segmental bronchial resection was performed at the perforation site and two cartilage rings were excised, with subsequent exposure of the oesophagus. Two oesophageal perforations were identified and repaired longitudinally with a two-layered closure with PDS (polydioxanone) 4.0 and 3.0. The IMA pedicled graft was used to cover the entire length of the oesophageal repair in a tension-free fashion. Bronchial reconstruction was performed through an end-to-end anastomosis with a continuous PDS 3.0. Postoperative course was uneventful except for a superficial sternal wound infection. The patient could be discharged on postoperative day 15. At 3 months follow-up, no evidence of recurrent fistula was found.

CASE 2
A 46-year-old male was referred with loco-regional recurrence of non-small-cell lung carcinoma (NSCLC), centrally located in the right upper lobe (RUL) and a separate paracardial mass 3 years earlier. Initial treatment consisted of concurrent chemoradiotherapy. Two years later, infield recurrence was observed at both sites. Despite additional chemotherapy regimens, progression of disease was evident. Distant metastases were ruled out by 18-fluorodeoxyglucose positron emission tomography (FDG-PET), and surgical resection was scheduled through a trans-sternal approach. After sternotomy, the paracardial mass was resected en

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extracorporeal circulation support. A right IMA pedicled graft was added, an intrapericardial approach through sternotomy also concomitant cardiac procedures, resection of anterior mediastinal access may be favourable for bilateral pulmonary procedures, cardiac operations. For general thoracic procedures, trans-sternal Median sternotomy is the gold standard approach for most DISCUSSION

A 61-year-old male was referred to our centre with locoregional recurrence of NSCLC. Two years earlier, a centrally located NSCLC was diagnosed in the right lower lobe (RLL). An exploratory thoracotomy was performed in another centre, and the tumour was deemed irresectable for unknown reasons. The patient was treated with concurrent chemoradiotherapy. During follow-up, locoregional recurrence was detected, and surgical resection was scheduled through a trans-sternal approach. Intraoperatively, extensive adhesions were present from the right lung with the thoracic wall and mediastinum. Intraproccedal pneumonectomy was performed with extravascular circulation support. A right IMA pedicled graft was used to cover the bronchial stump. Pathological examination revealed a radical resection without evidence of mediastinal lymph node metastasis (ypT4N0M0). Postoperative course was uneventful. No evidence of bronchopleural fistula (BPF) was found at 6 months follow-up.

CASE 3

A 61-year-old male was referred to our centre with locoregional recurrence of NSCLC. Two years earlier, a centrally located NSCLC was diagnosed in the right lower lobe (RLL). An exploratory thoracotomy was performed in another centre, and the tumour was deemed irresectable for unknown reasons. The patient was treated with concurrent chemoradiotherapy. During follow-up, locoregional recurrence was detected, and surgical resection was scheduled through a trans-sternal approach. Intraoperatively, extensive adhesions were present from the right lung with the thoracic wall and mediastinum. Intraproccedal pneumonectomy was performed with extravascular circulation support. A right IMA pedicled graft was used to cover the bronchial stump. Pathological examination revealed a radical resection without evidence of mediastinal lymph node metastasis. There were two separate nodules, one central in the RLL and one central in the pulmonary hilum, <2 cm of the main carina (ypT3N0M0).

Postoperative course was complicated by atrial fibrillation, pneumonia and a prolonged stay in the intensive care unit with inotropic support. The patient could be discharged on postoperative day 24. No evidence of BPF was found at 6 months follow-up.

DISCUSSION

Median sternotomy is the gold standard approach for most cardiac operations. For general thoracic procedures, trans-sternal access may be favourable for bilateral pulmonary procedures, concomitant cardiac procedures, resection of anterior mediastinal masses and access to the lower trachea and mainstem bronchi. In addition, an intrapericardial approach through sternotomy also facilitates resection of large hilar tumours, especially if the main pulmonary artery is involved [2]. Moreover, a trans-sternal approach seems particularly indicated for the treatment of post-pneumonectomy BPF [3].

When a vascularized pedicle is warranted for prophylactic coverage of the bronchus or oesophagus, the available options differ between a trans-sternal approach and a thoracotomy approach. Pedicled pericardial flap, thymic fat pad or mediastinal tissue is usually available after median sternotomy. However, the use of thoracic muscles flaps, i.e. serratus anterior, lattissimus dorsi and major pectoralis muscle flaps, usually requires an additional incision for adequate transposition. The intercostal muscle flap, one of the most versatile and commonly used option in a thoracotomy approach [1], seems technically challenging to harvest through a sternotomy incision. Transposition of the greater omentum is commonly used for reconstruction of infected sternotomy wounds, although extension of the incision into the upper abdomen is necessary for appropriate harvest. In addition, previous major abdominal operations and severe cachexia are important contraindications for the use of omental flaps.

The IMA is nowadays a mainstay conduit in coronary artery bypass grafting (CABG). Moreover, when the IMA is harvested as a pedicled graft [4], it can become an excellent option for prophylactic flap coverage with appropriate length and volume. For example, wrapping of the bronchial anastomosis during lung transplantation with an IMA pedicle graft has been shown to promote early bronchial revascularization and to provide submucosal vascular ingrowth in canine models [5]. However, the use of IMA pedicle wrapping did not lead to a reduction of incidence of bronchial anastomotic complications after single-lung transplantation in a randomized clinical trial [6], and routine use has been abandoned. Nevertheless, the IMA pedicle is a versatile, easy-to-harvest option for prophylactic flap coverage when thoracic surgery is performed through a sternotomy, especially in cases where the use of a greater omentum flap is not feasible or not preferred. IMA harvesting can usually be completed in 15–30 min and can be performed before or after pulmonary resection, depending on the surgeon’s preference. After sternotomy, a self-retaining IMA retractor can be used allowing constant upward and outward retraction of the chest wall (Fig. 1). In addition, rotating the operating table away from the surgeon will improve visualization of the mammary bed. The IMA can be identified approximately 1–2 cm lateral to the sternum border, posterior to the first six costal cartilages. The endothoracic fascia is incised at least 1 cm medial and 1 cm lateral to the IMA to create a broad pedicle including the accompanying veins, surrounding tissue, muscle and fascia. With gentle traction on the pedicle, arterial and venous side branches of the IMA to the chest wall at the level of the intercostal spaces will be exposed and can be clipped or cauterized. Proximally, the sternothyroid muscle, and distally, the transverse thoracic muscle should be divided to facilitate dissection and maximize the length of the pedicled graft. For optimal length, the IMA can be dissected from the first rib to its termination beyond the bifurcation in the rectus sheath. The rectus sheath can be opened to obtain additional length of the graft. After complete dissection of the graft, it may be ligated distally immediately or left in situ until use, depending on the timing of the IMA harvesting. A pedicled graft with a length of 20–25 cm can be obtained in this fashion, which will allow tension-free coverage of the bronchial tree of even the lower lobes (as illustrated in Case 2) or parts of the proximal half of the oesophagus. Similar to the CABG setting, we prefer to use papaverine to treat vessel spasm, maximize IMA...
flow and potentially increase graft viability, by applying papaverine solution externally or wrapping the pedicle in a papaverine-soaked gauze.

In conclusion, we advocate the use of an IMA pedicle as prophylactic flap coverage in patients with high-risk oesophageal or bronchial repair, operated on through a median sternotomy.

Conflict of interest: none declared.

REFERENCES


