Review Article

Techniques of protection and revascularization of the bronchial anastomosis

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Contributions: (I) Conception and design: F Venuta, M Anile; (II) Administrative support: None; (III) Provision of study materials or patients: None; (IV) Collection and assembly of data: None; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Abstract: Airway anastomosis has been traditionally considered at risk for the onset of complications, particularly dehiscence with consequent infection and erosion in the adjacent vessels. Although the modifications and improvements of the surgical technique has contributed to reduce the incidence of complications, the protection and revascularization of the anastomotic site is still considered mandatory at many centers Many techniques have been proposed for encircling the bronchial anastomosis.

Keywords: Sleeve resection; bronchial anastomosis; lung cancer

Submitted Dec 18, 2015. Accepted for publication Dec 21, 2015.
doi: 10.3978/j.issn.2072-1439.2016.01.68
View this article at: http://dx.doi.org/10.3978/j.issn.2072-1439.2016.01.68

Airway reconstructions with end-to-end anastomosis are usually performed in case of bronchoplastic procedures such as sleeve lobectomy (1-3) or sleeve pneumonectomy with carinal resections (4) and lung transplantation (5,6). This anastomotic site has been traditionally considered at risk for the onset of complications, particularly dehiscence and erosion in the adjacent pulmonary artery (PA). Although the surgical technique has been modified (5) and the incidence of complications has progressively decreased, many groups still consider mandatory the protection and revascularization of the anastomotic site. On the other side, there are reports supporting that unprotected bronchial anastomosis is safe even after induction chemotherapy (7) and lung transplantation (8).

Many techniques have been proposed for encircling the bronchial anastomosis. Pleural, pericardial and thymic flaps have been used successfully; however, the use of muscle flaps, particularly the intercostal muscle flap, is preferable since it contains its own blood supply and is less prone to shrinkage and fibrosis (9). These techniques have been also used to reinforce the bronchial stump after lobectomy and pneumonectomy (9,10).

Intercostal pedicle flap

The preparation of this flap is usually performed before entering the chest, to avoid crushing with the rib retractor, which is inserted only when the flap is ready and placed in the posterior aspect of the chest (11-14). The periosteum of the upper rib of the intercostal space involved at thoracotomy is incised and separated from the bone along with the underlying intercostal muscle. A sufficient flap of parietal pleura is mobilized upward by finger dissection along with the intercostal muscle. The preservation of the periosteum is crucial to avoid injuring the intercostal bundle. The upper part of the flap is now ready. The intercostal muscle is now incised at the level of its insertion of the underlying rib preserving a flap of pleura also on this side. At this level it is not required to incise the periosteum that remains in place. This maneuver allows reducing the thickness of the flap and this layer of muscular fibers left in place helps to fill the gap between the ribs when closing the chest, preventing the onset of subcutaneous emphysema in case of air leaks. Thickness is an important issue: a thin flap slides more easily between the bronchus and the PA without

any compression of the vessel. Only at this point the rib spreader can be inserted and the flap is divided anteriorly, at the level of the costo-chondral junction, ligating the extremity; a silk tie is left attached to this extremity of the flap to improve the subsequent sliding maneuver.

After completing the bronchial anastomosis, a right angle clamp is slid between the PA and the bronchus and the silk tie is grasped and withdrawn backward with the flap. The intercostal muscle is gently twisted leaving the pleural surface in contact with the bronchus. The pleura is secured to the bronchus with interrupted absorbable 4-0 sutures.

The thoracoscopic preparation of an intercostal muscle flap has been reported (15), although in that case it was used to reinforce a standard lobectomy bronchial stump and the service thoracotomy was a little too long for the current thoracoscopic lobectomy standards (8 cm). Robotic preparation of the intercostal muscle flap has also been described by Lazzaro in 2013 (16).

This preparation of the intercostal muscle is advisable in case its need it is anticipated preoperatively; if not used, the flap can be placed again between the ribs while closing the thoracotomy. However, there are cases in which the need of a bronchial sleeve resection requires intraoperative confirmation. In these situations, the surgeon would add operative time preparing an unnecessary flap or have a useless intercostal muscle crushed by the rib spreader, requiring mobilization of other flaps. In such patients it might be advantageous to prepare the segmental nondivided intercostal muscle flap during thoracotomy (17,18). This technique has been described to decrease postoperative pain after thoracotomy (18,19). According to this technique, mobilization from the rib is required only at the level where the retractor is placed; it takes only a few minutes and it makes the intercostal muscle available in case on an unexpectedly complicated surgical resection. If the flap is required mobilization can be completed as previously described. If the flap is not required the minimal mobilization allows easy closure of the chest.

Assessment of the quality of the pedicled intercostal muscle flap could be useful before using it. For this purpose indocyanine green fluorescence (ICG) have been used (20); after injection ICG fluorescence imaging is assessed with a near—infrared camera system visualizing the presence of poor perfused areas within the pedicle.

No early complications have been recorded with the preparation and use of the intercostal muscle pedicle. Ossification of the pedicle is a well-known phenomenon (11,21,22) with uncertain clinical implications. In previous reports we described this phenomenon without any clinical significance (11,23), in line with other authors (24). However, other authors have reported the occurrence of a bronchial stricture as a consequence of ossification (18,25). In an experimental study Fell (22) showed that cauterization of the periosteum with 30% silver nitrate contributes to reduce the amount of calcification; he suggested (26) loose wrapping of the pedicle around the bronchial anastomosis. Harvesting with a cautery so it is devoid of periosteum avoid calcification (27,28).

Pleural flaps

Pleural flaps have been initially described to reinforce the pneumonectomy (29) and lobectomy (30) stumps and subsequently have been interposed between the bronchial anastomosis and PA in sleeve lobectomy (31). The pleural flap is harvested after thoracotomy; a triangular incision with the medial base of the flap one-third the width of the distal side; the proximal side arrives close to the mediastinum. The edges of the flap are gently lifted and a plane is dissected under the parietal pleura to its base. The flap is subsequently folded around the bronchial anastomosis and fixed to the bronchus with absorbable suture.

Pericardial flaps

Pericardial flaps are used in a great number of situations: to protect tracheal or bronchial anastomoses, including sleeve resections (31-35), to repair recurrent tracheoesophageal fistulas (36,37), and to repair congenital tracheal and esophageal stenosis (38). To prepare the flap, the pericardium is incised avoiding injuring the pericardiophrenic bundle and it is rotated to wrap the anastomosis or protect the suture line. The pericardial defect usually does not require closure unless pneumonectomy is performed.

Pericardial fat pad graft

This pedicle is usually employed to reinforce and protect bronchial stumps since it is difficult to obtain a graft of adequate length to wrap a bronchial or tracheal anastomosis. It was described first by Brewer in 1953 (39). The pedicle is usually freed off the pericardium based on the middle pericardial and musculophrenic branches of the internal mammary artery (9). The anastomotic vessels to the pericardiophrenic branch anteriorly and musculophrenic artery inferiorly are divided (9). The graft consists of the

overlying mediastinal pleura, adipose tissue and blood vessels and can be fixed in its final position. Alternatively, a shorter graft can be harvested by the antero-superior fat pad, where the blood supply originates from the superior pericardial branch of the internal mammary artery and anterior mediastinal vessels.

Pedicled pericardiophrenic graft

This graft is useful only in patients undergoing pneumonectomy, to protect the bronchial stump, or to wrap the anastomosis after carinal pneumonectomy. It consists of mediastinal pleura, phrenic nerve, and the adipose tissue surrounding the pericardiophrenic bundle. This pedicle is mobilized upward dividing the vessels above the diaphragm (9).

Omentum

The omentum is extremely useful to protect and reinforce any anastomosis and suture within the chest (40-43). It can be easily mobilized with a small incision and transposed within the chest. Its use to wrap the bronchial anastomosis was crucial in the early days of lung transplantation to solve the anastomotic problems.

The omentum derives its blood supply from the right and left gastroepiploic vessels forming an arcade within the fat tissue. The length of the omentum is about 3 cm and the width is about 40 cm. The omentum can be further mobilized by dividing the attachments with the transverse colon, with a pedicle based on the right gastroepiploic vessels, freeing the arcade from the stomach. By dividing the left gastroepiploic vessels the length of the flap is increased so much that it could reach the neck.

The omentum with its length and adequate vascular supply provides enough soft tissue for coverage and wrapping, it functions also in infected fields, it provides fibroblasts and healing and enhances neovascularity.

Peribronchial mediastinal tissue

This tissue is specifically used to cover the bronchial anastomosis during lung transplantation by approximating the peribronchial donor and recipient tissue. This provides adequate protection of the bronchial anastomosis and separates it from the vascular side in case of anastomotic breakdown (4,44).

Overall, many flaps have been used to protect airway anastomosis after reconstruction. The selection of the most appropriate is related to the anatomic characteristics of each patient and the type of surgical procedure. The critical point, once selected the most appropriate flap, also on the base of the surgeon preference, is to harvest and maintain it well vascularized and vital. This in the only condition, along with an adequate length, to provide an effective coverage and protection of the anastomosis.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Cite this article as: Venuta F, Diso D, Anile M, Rendina EA. Techniques of protection and revascularization of the bronchial anastomosis. J Thorac Dis 2016;8(Suppl 2):S181-S185. doi: 10.3978/j.issn.2072-1439.2016.01.68