Life-saving muscle flaps in tracheobronchial dehiscence following resection or trauma

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Abstract

Objective: In the presence of acute inflammation and necrosis of the wall, tracheobronchial defects are difficult to manage. The absence of adequate vascularization and the contaminated area prevent successful direct re-sutting. Methods: In order to restore a sufficient blood supply we used a pedicled latissimus dorsi or a pectoralis major flap that was entered into the thorax after a 10-cm resection of the second rib. A portion of the muscle was fitted into the tracheobronchial defect by reinforced sutures. The remaining muscle was sutured to the tissue surrounding the defect. This method was applied in various septic conditions: Bronchial defects; complete dehiscence of the right (n = 6) or left (n = 1) main bronchus at the carinal level following resection for lung cancer (n = 4) or for tuberculous (n = 2) or nontuberculous pleuropneumonia (n = 1). Tracheal defects; (1) destruction of one third of the tracheal circumference involving the cricoid down to the fourth ring following tracheotomy in presence of a septic sternum after intrathoracic goiter and Bechterew's disease; (2) 30% dehiscence of the anastomosis and septic sternum following tracheal resection; (3) Mediastinitis involving tracheal and esophageal wall following a 7 cm long iatrogenous laceration of the intrathoracic trachea. Results: In one case the latissimus dorsi developed venous stasis on day 2 and was replaced by the pectoralis major muscle which showed uneventful healing. In all other patients the muscle flap resulted in an uneventful closure of the defect and recovery. Conclusions: Large, well vascularized, pedicled muscle flaps ensure a safe closure of tracheobronchial defects or dehiscences even in presence of gross necrosis and sepsis. © 1997 Elsevier Science B.V.

Keywords: Bronchial defect; Tracheal defect; Sepsis; Closure; Muscle-flap

1. Introduction

Bronchial dehiscence after resection involving the carinal region or large defects of the tracheal wall after operation or trauma are not easy to manage, as empyema or mediastinitis are usually present. If the tracheobronchial wall is inflamed or necrotic, bronchoplastic techniques are necessary, as there is not enough tissue left to enable direct suture [2,6,7]. Patients who present with defects of the tracheal and/or bronchial wall and consecutive spread of infection are in a poor general condition: sepsis and multiorgan failure necessitate a quick, reliable and little compromising method for closure of the leakage.

We present 10 cases with severe sepsis due to postinterventional tracheal or bronchial leakage who underwent myoplastic closure using the major pectoralis or the latissimus dorsi muscle.
Table 1

<table>
<thead>
<tr>
<th>No.</th>
<th>Age/sex</th>
<th>History/primary diagnosis</th>
<th>Secondary diagnosis</th>
<th>Interval from initial operation or trauma (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48/m</td>
<td>Right pleuro-pneumonecomy/necrotizing pneumonia, empyema</td>
<td>Necrosis of the bronchial stump and right distal tracheal wall, total dehiscence, empyema, multi-organ failure</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>64/m</td>
<td>Right pneumonectomy/lung cancer</td>
<td>1-cm Fistula of the bronchial stump, empyema, sepsis</td>
<td>137</td>
</tr>
<tr>
<td>3</td>
<td>68/m</td>
<td>Right pleuropneumonectomy/tuberculosis</td>
<td>50% Dehiscence of the bronchial stump, empyema, sepsis</td>
<td>63</td>
</tr>
<tr>
<td>4</td>
<td>54/m</td>
<td>Right pneumonectomy for lung cancer</td>
<td>Necrosis of the bronchial stump, total dehiscence, one cm necrosis at the left main bronchus, empyema, sepsis</td>
<td>37</td>
</tr>
<tr>
<td>5</td>
<td>55/m</td>
<td>Right pleuro-pneumonectomy/necrotizing pneumonia, empyema</td>
<td>Necrosis of the bronchial stump, total dehiscence, empyema, sepsis, multiorgan failure</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>51/m</td>
<td>Right pneumonectomy/lung cancer</td>
<td>50% Dehiscence of the bronchial stump, empyema, sepsis</td>
<td>94</td>
</tr>
<tr>
<td>7</td>
<td>76/m</td>
<td>Left pneumonectomy/lung cancer</td>
<td>100% Dehiscence of the bronchial stump, empyema, sepsis, contralateral aspiration of pus</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>60/m</td>
<td>Tracheostomy/goiter thyroid resection over sternotomy; Bechterew’s disease</td>
<td>Dehiscence of sternum, bilateral empyema, defect from thyroid cartilage to 4th tracheal ring, continuous reinfection over stoma, sepsis, multiorgan failure</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>79/w</td>
<td>Tracheal resection over sternotomy (Pearson)/cicatriceal stenosis</td>
<td>Dehiscence of right circumference of the anastomosis, dehiscence of sternum, sepsis, multiorgan failure</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>55/w</td>
<td>General anaesthesia with intubation/panaritium of the index</td>
<td>7-cm Tracheal laceration, necrosis of esophageal muscle layer, mediastinitis, sepsis</td>
<td>5</td>
</tr>
</tbody>
</table>

2. Patients and methods

2.1 Patients

Since 1989 we have treated 10 patients (8 males, 2 females; age: 45–79 years) with sepsis due to a large tracheobronchial leakage. Three of them had had right pleuro-pneumonectomy for necrotizing tuberculous (N= 1) or nontuberculous (N= 2) pneumonia and empyema. In three cases right and in one case left pneumonectomy for lung cancer with extensive subcarinal and paratracheal lymph node dissection had been done. In all instances the resection line at the main bronchus had been at the carinal level.

Further patients (3) presented with large leaks of the tracheal wall (one following atypical tracheostomy in Bechterew’s disease, one after tracheal resection, one had a large intrathoracic tracheal laceration).

After an interval ranging from 4 to 137 days after initial surgery or trauma, respectively, the patients developed signs of a fistula. One patient, who had declined the scheduled follow-up investigations presented with severe symptoms 10 years after surgery (see Table 1). In all postpneumonectomy cases a large dehiscence of the suture line was present, the leakage reaching the level of the trachea. In one case an additional necrotic area at the contralateral bronchus was found. In 3 patients the predominant feature was gross necrosis at the bronchial stump with recent empyema (cases 1, 4, 5), in the others chronic empyema with thick callosities was found, the leakage presenting as a discolored hole in the mediastinal callosity.

Both postoperative tracheal defects were associated with septic dehiscence of the sternotomy. In the case of Bechterew’s disease, the tracheostomy had an extent of one third of the circumference extending from the thyroid cartilage down to the fourth tracheal ring. The dehiscence following tracheal resection involved 50% of the right circumference with necrosis of the distal cartilage. The intrathoracic tracheal laceration was diagnosed because of unexplained sepsis on the 5th day after anaesthesia for a panaritium. The 7-cm laceration had caused necrosis of the membranaceous wall and of the adjacent esophageal muscle layer.

All patients had severe sepsis with multiorgan failure and need for hemodialysis in four cases. All but one (case No. 7) had to be put on artificial ventilation with selective left-sided intubation in the postpneumonectomy cases and intubation with the cuff inflated distal to the lesion in the patients with tracheal defects.
Table 2

<table>
<thead>
<tr>
<th>No.</th>
<th>Age/sex</th>
<th>Muscle used for</th>
<th>Duration of hospitalization (days)</th>
<th>Further course</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45/m</td>
<td>Latissimus dorsi</td>
<td>29</td>
<td>Uneventful healing; closure of thoracostomy</td>
</tr>
<tr>
<td>2</td>
<td>64/m</td>
<td>Pectoralis major</td>
<td>23</td>
<td>Uneventful healing; closure of thoracostomy</td>
</tr>
<tr>
<td>3</td>
<td>68/m</td>
<td>Pectoralis major</td>
<td>51*</td>
<td>Uneventful healing; closure of thoracostomy; chronic pain due to resection of 4 ribs</td>
</tr>
<tr>
<td>4</td>
<td>54/m</td>
<td>Latissimus dorsi, pectoralis major</td>
<td>42</td>
<td>Venous stasis of latissimus dorsi after 24 h; secondary use of pectoralis major. Uneventful healing; no closure of thoracostomy</td>
</tr>
<tr>
<td>5</td>
<td>55/m</td>
<td>Pectoralis major</td>
<td>29</td>
<td>Uneventful healing; closure of thoracostomy</td>
</tr>
<tr>
<td>6</td>
<td>51/m</td>
<td>Pectoralis major</td>
<td>37</td>
<td>Uneventful healing; closure of thoracostomy</td>
</tr>
<tr>
<td>7</td>
<td>76/m</td>
<td>Latissimus dorsi</td>
<td>34</td>
<td>Uneventful healing; closure of thoracostomy</td>
</tr>
<tr>
<td>8</td>
<td>60/m</td>
<td>Pectoralis major</td>
<td>78b</td>
<td>Uneventful healing; myoplastic repair of the sternal dehiscence</td>
</tr>
<tr>
<td>9</td>
<td>79/w</td>
<td>Pectoralis major</td>
<td>92c</td>
<td>Uneventful healing; myoplastic repair of the sternal dehiscence</td>
</tr>
<tr>
<td>10</td>
<td>55/w</td>
<td>Pectoralis major</td>
<td>17</td>
<td>Uneventful healing</td>
</tr>
</tbody>
</table>

* Prolonged recovery due to irritation of the intercostal nerves.
* Prolonged weaning period.
* Prolonged recovery due to renal problems and old age.

2.2. Technique

Postoperative pleural empyema was treated by open thoracostomy resecting 2–4 ribs, performing empyema decortication as far as possible. In the presence of a septic sternum the wires were removed and the sternotomy was left open.

A pedicled flap from the cranial part of the latissimus dorsi (n = 3) that remained after severing the muscle during thoracotomy, or a pedicled flap comprising the caudal two thirds of the ipsilateral pectoralis major muscle (n = 8) was dissected. Great care was taken to preserve the arteries and the venous drainage. The respective muscle was entered into the thorax after a 10 cm wide resection of the second rib beginning 2 cm lateral of the sternal border. A portion of the muscle was fitted to the tracheal or bronchial defect using reinforced sutures which were positioned in a way that ensured perfusion of this very part of the muscle. The remaining muscle was sutured to the tissue surrounding the defect. In the large tracheal defect after tracheostomy a segment of corium and subcutis was left on the pectoralis major muscle in a pedicled position. The corium was tightly sutured to the lower border of the thyroid cartilage, to the stumps of the resected cricoid and tracheal cartilages and to the fourth tracheal ring, securing the carrying muscle to the lateral tracheal wall.

In all cases the thoracotomy or the sternotomy were left open for daily changes of dressings until a safe healing of the tracheobronchial wall was ensured. Secondary closure of lateral thoracotomies was done with the help of myoplastic techniques using the latissimus dorsi and also the serratus anterior muscle, if necessary. In one case (case No. 4) the patient refused the myoplastic closure and was discharged with the thoracostomy left to clean granulative tissue. Myoplasty using the rectus abdominis and/or pectoralis major muscles was applied for closure of sternotomies covering the medial surfaces of the sternal halves with one muscle each. The sternal halves were not re-sutured, only the overlying skin was closed.

3. Results

All patients underwent repetitive fibrebronchoscopical examinations, with the first one done on the second postoperative day. In tracheal lesions the endotracheal tube was temporarily pulled back to enable an inspection of the closed defect. During the daily change of dressings of the thoracostomy or sternotomy wound both the perfusion of the flap and the absence of an air leak at the suture line were assessed.

In one case the latissimus dorsi developed venous stasis on day 2 and was replaced by the pectoralis major muscle which showed an uneventful healing. In all other patients the muscle flap resulted in an uneventful closure of the defect (see Table 2). In case No. 4 in which the muscle was wrapped to the subcarinal region also the necrosis of the contralateral bronchus healed rapidly showing complete re-epithelization on day 17.

Within 1 week the infection was controlled in each case. Bacteriological specimens and laboratory parameters (C-reactive protein, WBC, renal and hepatic function parameters) documented the healing process.

Weaning from the artificial ventilation was begun on postoperative day 4–9, depending on the general condition and on the sepsis parameters. After a final endoscopic control the patients were extubated.

From the respiratory point of view, the results were excellent: No stenosis whatsoever was found during the...
follow-up period (9–26 months). No re-opening of the fistula and no infectious complications at the site of the myoplasties or in the pneumonectomy cavities were noticed. After 6 months the site of myoplasty could hardly be identified by bronchoscopy any longer.

There was, however, a functional impairment of the upper extremities: At the side from which the pectoralis major muscle had been taken, a slight deficiency in adduction and inside rotation was invariably found, but the patients did not feel disabled by this fact. The use of the latissimus dorsi remained unnoticed for the patients subjective feeling, though a slight deficiency in the backward movement of the arm could be objectivated. Predictably, the most pronounced symptoms resulted in the to patients in whom both the serratus anterior and the caudal pectoralis major muscles had been involved in the repair of the bronchial defect and the chest wall: a > 90° abduction in the shoulder joint was not possible. However, in all cases face and back of the head could be sufficiently reached with the respective hand and the patients did not feel disturbed by their functional impairment.

4. Discussion

Large complicated tracheal or bronchial defects arising after surgery or following trauma are still an eminent problem in thoracic surgery. In spite of meticulous suturing techniques and further precautions including covering of the bronchial stump or of anastomoses with pedicled vital tissue, dehiscence can never totally be prevented. In our collective of pneumonectomies we observe a relatively constant rate ranging between 2.5 and 2.9%. Especially in severely ill critical care patients, repair has to be quick, with as little compromising as possible and reliable.

Most postoperative bronchial stump dehiscences are associated with a poor vascular supply to the bronchial wall following 'overradical' dissection of the parabronchial area: Thus attempting to repair a complicated stump insufficiency by only relying on the bronchial tissue itself, such as endoscopic closure using different types of sealant [19,20] or other semi-conservative measures, will result in long-term drainages and in a high rate of complications [8,16,17].

As soon as severe concomitant infection has evolved, direct intrapleural re-suturing is no-longer advisable. Extrapleural techniques for closure of dehiscent bronchial stumps using either the median transsternal, transpericardial approach [2,6] have been successfully used. However, they require a bronchial stump of sufficient length, as a de-novo resection is necessary to avoid recurrent fistula.

The use of an autologus pericardial flap carries the risk of pericarditis and is often technically impossible due to callosities of the mediastinal pleura if the transthoracic approach is used. Theoretically, these problems can be overcome by dissecting the flap over a median, transsternal incision using it to secure the stump during transpericardial re-resection. However, a stump of sufficient length is necessary for this procedure [1]. Moreover, the mediocre vascular supply to the pericardium suggests its application rather for use in non-infected areas [9]. Flaps formed from pedicled parts of the greater omentum [3,21] or from pedicled strips of diaphragm [12] have a good vascularization. In the presence of severe empyema and sepsis, however, it does not seem to be always advisable to open the abdominal cavity, thereby risking a spilling of the infection to the peritoneum. A further limitation results from the fact that the diaphragm is often involved in thick pleural callosities which may prevent its use as a covering flap. The same is true for the ancient technique of thoracoplasty using covering flaps derived from the intercostal muscle bundles, the vascularization of which is poor [16,18].

Pedicled serratus anterior, latissimus dorsi, or pectoralis muscles have been reported for intrathoracic application. However, although their merit is undisputed [5,7,8,13,15,22] they do not seem to be widely used. In a comparative retrospective review, Hankins [8] found the lowest rate of fistula-related deaths in patients treated by myoplasty. Up to this time, the most frequent use of transposed muscle has been for interposition after repair of esophagotracheal fistula [7]. In most cases the already sutured bronchial stump or tracheal segment was only wrapped [10,14] by the muscle.

As to our experience, the excellent vascularization of the latissimus dorsi and pectoralis major muscle with abundant intramuscular anastomoses allows their application even in highly contaminated regions: The improved supply of oxygen and the viability for antibiotics add up to a rapid elimination of bacteria with subsequent healing [4]. In addition to the closure of the tracheobronchial defect itself, the fixation of the muscle to the adjacent tissue provides an improvement of the microvascularization in the vicinity of the leakage.

Open drainage through a thoracostomy provides a rapid cleansing of all pleural surfaces resulting in a quick recovery from sepsis. Moreover, direct visualization allows a perfect control of the perfusion of the muscle flap [15]. This enables immediate corrective surgery in case of perfusion problems. As to our experience, the pectoralis major muscle is preferable for closure of defects localized in the trachea and in the central tracheobronchial tree, as it can be positioned flatly to the mediastinum in all its length. Though equally well perfused, the latissimus dorsi muscle can often be used in part only, as it may have been severed during the preceding thoracotomy. Moreover, in order
to be fixed to the central mediastinal structures it has to cross the pleural cavity, resulting in a constant tear at the fixation area.

When closing a defect of the tracheal wall mechanical stability has to be warranted; we used a tightly extended muscle-pedicled corium as the innermost layer for closure of the large anterior tracheal defect. Pleura-covered autologous bone transplants have been reported for tracheal repair, [11] but they are not likely to ensure sound healing in severely septic conditions.

A functional impairment of the upper extremity can be objectivated in each case and is worse if the serratus anterior has been severed. This is why we try to avoid its use, though other authors prefer this muscle [13]. Subjectively, however, the patients hardly feel disabled, even if more than one muscle has been taken.

In conclusion, severe sepsis following tracheal or tracheobronchial defects warrants a quick surgical repair. Our own experience in critically ill patients confirms the favourable reports on the use of pedicled muscle flaps in tracheo-bronchial fistulae.

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