Surgical maneuvers for the management of bronchial complications in lung transplantation

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Received 7 April 2008; received in revised form 8 June 2008; accepted 11 June 2008; Available online 19 August 2008

Abstract

Background: Many advances have substantially improved the clinical results of lung transplantation. However, the incidence of bronchial complications is still high, with significant impact on survival and limited interventional strategies for complex cases. Our aim is to evaluate the surgical management of bronchial complications following lung transplantation.

Methods: From May 1989 to June 2007, 251 patients were submitted to lung transplantation at our institution. In five cases, the bronchial complications observed were dealt with open surgical procedures.

Results: Complications surgically dealt were one broncho-arterial fistula and four stenosis. One left upper sleeve lobectomy, one right upper sleeve lobectomy and three segmental bronchial resections with anastomosis were performed. In all five cases the surgical procedure was successful and optimal bronchial healing was observed. Three patients died due to causes unrelated to the bronchial anastomosis 5, 21 and 32 months after the bronchoplastic procedure. Two patients are still alive and functionally well at 52 and 70 months post-bronchoplasty.

Conclusions: Surgical management of bronchial complications after lung transplantation may be the last resort in complex, recalcitrant cases, nevertheless it is a feasible procedure and can provide good results not only on short- but also long-term follow-up.

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Keywords: Anastomosis; Bronchial disease; Lung transplantation; Complications; Surgery

1. Introduction

Since the description of the Toronto Lung Transplant Group in 1987 of a bronchial dehiscence after successful transplantation, it became clear to most lung transplant teams that airway complications would pose a substantial barrier to the improvement of clinical results [1]. Nowadays, with consistent advances in surgical technique, organ preservation, patient selection, postoperative care, including critical care management, long-term outpatient follow-up and immunosuppression, the overall results are unequivocally superior; nonetheless, bronchial complications still represent a surgical dilemma [2,3]. Treatment options are far from ideal, including bronchoscopic dilatation, laser therapy and stent placement. Literature regarding the surgical strategies to overcome these issues is scarce, limited to few case reports or series with no long-term follow-up data. We report the long-term results of five patients who developed an airway complication post-transplant and required surgical correction.

2. Patients and methods

From May 1989 to June 2007, 251 patients underwent lung transplantation at our institution. Standard immunosuppression consisted of a three drug regimen with intra-operative methylprednisolone followed by a calcineurin inhibitor (cyclosporine), azathioprine and prednisone in the postoperative period. We do not use induction therapy. Airway anastomoses were performed with minimal peri-bronchial tissue dissection, with an end-to-end technique with absorbable running suture (PDS, Ethicon, Somerville, NJ) in the membranous wall and interrupted single suture in the cartilaginous wall. Whenever we observed a great discrepancy between donor and recipient bronchial sizes, the telescoping technique was employed. The anastomosis was routinely wrapped with donor pericardial tissue.

Bronchial complications requiring open surgical repair were reported in five patients. Patients’ characteristics are summarized in Table 1. Briefly, there were four male
patients; group mean age was 55 years, ranging from 44 to 62. In all five cases the transplant was motivated by interstitial fibrosis. In all cases the procedure was unilateral, four of them in the left side. Five cases suffered from reperfusion injury, graded according to the ISHLT score as 2 in three and 3 in two. Two patients were extubated 12 h after transplantation, one, 24 h, and the two remaining required a longer time weaning, 18 and 25 days. Acute rejection in the first month was documented both clinically and histologically after four of the five grafts and was treated with corticosteroids.

The mean time between the transplant and the reintervention was 98.8 days. In four instances, the bronchial complication observed was anastomotic stenosis and the diagnosis was suspected based on loss of pulmonary function. All of them were initially dealt with bronchoscopic dilatation. In three of these, a silicone stent was subsequently located. Adequate palliation was not obtained, so surgical intervention was indicated. In the remaining case, urgent reintervention was required due to a broncho-arterial fistula.

### 2.1. Surgical maneuvers

Patient 1 presented with acute respiratory failure and hemoptysis 15 days post-left lung transplantation. Bronchial dehiscence had been documented 2 days earlier and the attempt to conservatively manage it was frustrated. He underwent a left posterolateral thoracotomy; anastomotic dehiscence was confirmed along with partial thickness necrosis of the left main bronchus extending to the upper lobe branch. Furthermore, erosion of the left pulmonary artery and a local collection were observed. The vascular lesion was sutured and the devitalized tissue debrided, including the donor left main bronchus until the upper lobe branch. The remaining graft, left inferior lobe, was reanastomosed to the recipient bronchus with an absorbable running suture (PDS, Ethicon, Somerville, NJ). Wrapping with mediastinal fat was used.

In patient case 2, we have faced a dramatic clinical picture (Fig. 1). During an attempt to endoscopically dilate a right main bronchus stenosis, rupture of the anastomotic line developed. In the same anesthetic time, through a right posterolateral thoracotomy, a sleeve upper lobectomy was performed. The reanastomosis was performed as described in the previous case (Fig. 2). Mediastinal fat was used to wrap the anastomosis.

In the remaining three cases, all unilateral left-sided transplants, endoscopic attempts to manage fixed anastomotic stenosis have all failed, including prosthetic placement and all its inconveniences. They underwent similar procedures, a left posterolateral thoracotomy and segmental resection of the stenotic area followed by end-to-end reanastomosis, again, running absorbable suture and mediastinal fat wrapping (Figs. 3 and 4).

### Table 1

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex/age</th>
<th>Disease</th>
<th>Side</th>
<th>Days MV</th>
<th>Reperfusion injury</th>
<th>AR 1st month</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M/62 y</td>
<td>Fibrosis</td>
<td>L</td>
<td>0.5</td>
<td>Yes, grade III</td>
<td>Yes</td>
<td>Broncho-arterial fistula</td>
</tr>
<tr>
<td>2</td>
<td>M/61 y</td>
<td>Fibrosis</td>
<td>R</td>
<td>18</td>
<td>Yes, grade III</td>
<td>Yes</td>
<td>Bronchial stenosis</td>
</tr>
<tr>
<td>3</td>
<td>M/44 y</td>
<td>Fibrosis</td>
<td>L</td>
<td>1</td>
<td>Yes, grade II</td>
<td>No</td>
<td>Bronchial stenosis</td>
</tr>
<tr>
<td>4</td>
<td>M/55 y</td>
<td>Fibrosis</td>
<td>L</td>
<td>0.5</td>
<td>Yes, grade II</td>
<td>Yes</td>
<td>Bronchial stenosis</td>
</tr>
<tr>
<td>5</td>
<td>F/53 y</td>
<td>Fibrosis</td>
<td>L</td>
<td>25</td>
<td>Yes, grade II</td>
<td>Yes</td>
<td>Bronchial stenosis</td>
</tr>
</tbody>
</table>

M, male; F, female; y, years; OB, obliterative bronchiolitis; L, left; R, right; MV, mechanical ventilation; reperfusion injury graded according to the ISHLT grading system; AR, acute rejection.

Fig. 1. Computerized tomography (CT) displaying anastomotic stenosis in patient 2 (before ruptured in an attempt of bronchoscopic dilation).

Fig. 2. Patient 2 CT post-sleeve upper lobectomy day 30 displaying an adequate bronchial lumen.
3. Results

Surgical data and results are summarized in Table 2. Operative mortality was 0%. The mean anesthetic time was 252 min, ranging from 210 to 315 min. The mean blood loss was 646 ml, from 1880 to 100 ml, and in three of the five procedures, blood transfusion was required (mean 1.3 red blood cells unit, from 2 to 1 unit). The mean ICU and hospital stay were respectively 18.8 days, from 2 to 38 days; and 38.6 days, from 8 to 80 days.

Bronchoscopic follow-up confirmed resolution of anastomotic complication in all cases. Due to obliterative bronchiolitis, patient 1 underwent a right lung transplant 32 months after his initial left procedure. However, a large hemorrhagic stroke developed and he died on postoperative day 4. Patients 4 and 5 died due to pulmonary sepsis 21 and 5 months after bronchoplasty, respectively. Endoscopic examination revealed patent, adequate anastomosis in both cases. Patients 2 and 3 are alive and functionally well, the former 57 months and the latter 70 months after reintervention.

4. Discussion

The lung is the only solid organ to be transplanted without prompt reestablishment of its systemic circulation. Besides, the bronchial anastomosis is challenged by damaging stresses such as positive pressure from mechanical ventilation and bacterial contamination. In spite of substantial improvements in the field, these factors could not be overcome and the incidence of bronchial complications has not consistently changed in the past 15 years [3].

Recent studies have addressed this clinical picture and identified possible contributive factors. Murthy and co-workers [3] reported an incidence of 18% (48 of 272 patients). They highlighted a telescoping anastomosis technique and a previously treated airway complication as the most important risk factors. In their series, seven anastomotic complications (two obstructive and five necrotic) were managed with open surgical procedures. Nevertheless, more detailed data regarding these cases is not available.

Regarding the surgical treatment of bronchial complications, a series of three patients was recently reported [4]. All of them presented with nonanastomotic segmental stenosis and have failed to respond to interventional bronchoscopic measures. Postoperative course was unremarkable and short-term follow-up revealed optimal healing of the anastomoses. In the report of Shafer and co-workers [5], similarly to ours, three bronchoplastic procedures (two sleeve lobectomies and one resection with anastomosis) were performed to treat

Table 2
Operative procedure and results of surgical treatment of post-transplant bronchial complications

<table>
<thead>
<tr>
<th>Patient</th>
<th>Complication</th>
<th>PT</th>
<th>Procedure</th>
<th>Bleeding/TR</th>
<th>ICU/hospital stay</th>
<th>Survival</th>
<th>Alive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BA fistula</td>
<td>No</td>
<td>Sleeve upper lobectomy</td>
<td>500 ml/1 U</td>
<td>20/25 days</td>
<td>32</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Stenosis</td>
<td>BD</td>
<td>Sleeve upper lobectomy</td>
<td>1880 ml/2 U</td>
<td>29/66 days</td>
<td>70</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Stenosis</td>
<td>BD/SS</td>
<td>Resection + resuture</td>
<td>600 ml/1 U</td>
<td>38/80 days</td>
<td>57</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Stenosis</td>
<td>BD/SS</td>
<td>Resection + resuture</td>
<td>150 ml/0</td>
<td>5/14 days</td>
<td>21</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Stenosis</td>
<td>BD/SS</td>
<td>Resection + resuture</td>
<td>100 ml/0</td>
<td>2/8 days</td>
<td>5</td>
<td>No</td>
</tr>
</tbody>
</table>

BA, broncho-arterial; PT, previous treatment; BD, bronchoscopic dilatation; SS, silicone stent placement; TR, transfusion requirement in red blood cell unit; ICU, intensive care unit stay.
complex stenosis or distal bronchial necrosis. On short-term follow-up, all patients were alive and functionally well. In the contribution of Paulson and co-workers, a latissimus dorsi flap was used to cover an end-to-end bronchus intermedius anastomosis performed to treat a recalcitrant post-anastomotic stricture [6]. Pedicled muscle flaps may be used to protect these high-risk anastomoses, however, we have a preference for mediastinal fat, which may be simpler to harvest and provide as good results.

Conventional management of airway complications post-transplant is based on an armamentarium of endoscopic interventional options. Bronchoscopic balloon dilatation can achieve long-term resolution in 50% of cases, however, repeated procedures are often required [7]. Self-expandable metallic stents can provide better results, with bronchial complication resolution in more than 90% of patients after a mean follow-up of 20 months [8]. Other modalities include rigid bronchoscopic and laser debridement [9]. In spite of all these strategies, transplant teams have occasionally faced complex complications which are not always amenable to endoscopic treatment. Nonanastomotic stenosis, stenosis extending to lobar bronchi and significant necrosis from the anastomatic line to lobar orifices represent the most striking pictures. In these instances, reconstruction may be technically challenging and sleeve lobectomies are often required. Nevertheless, our report, along with the others cited herein, supports the concept that surgical strategies can provide consistent resolution of bronchial complications in this high-risk population.

References