

Chapter 17

Surgery for bronchiectasis



D.C. Mauchley* and J.D. Mitchell*^{†,‡}

Summary

Surgical resection for bronchiectasis should be reserved for patients with localised disease who have failed medical management and have persistent symptoms that negatively affect their quality of life. Patients with unilateral segmental disease have the best outcomes. The key to successful surgical intervention includes: 1) complete resection of all affected areas; 2) relatively early intervention to prevent development of resistant organisms and spread to adjacent lung segments; 3) pre-operative targeted antimicrobial therapy based on *in vitro* sensitivities; 4) continuation of antimicrobial therapy post-operatively; 5) pre-operative nutritional supplementation when indicated; and 6) anticipation of potential complications that may alter the surgical approach. Surgical resection can be accomplished with minimal morbidity and mortality and it can usually be completed with a video-assisted thoracoscopic approach. The only surgical option for diffuse bronchiectasis is bilateral lung transplantation and is mainly employed when treating patients with cystic fibrosis.

Keywords: Bronchiectasis, lobectomy, lung transplantation, pulmonary infections, segmentectomy, video-assisted thoracic surgery

*Dept of Surgery, Division of Cardiothoracic Surgery, Section of General Thoracic Surgery and Center for the Surgical Treatment of Lung Infections, University of Colorado Denver, Aurora, and
[†]National Jewish Health, Denver, CO, USA.

Correspondence: J.D. Mitchell, Section of Thoracic Surgery, Division of Cardiothoracic Surgery, C-310, University of Colorado, Denver School of Medicine, 12631 E. 17th Avenue, C310, Aurora, CO 80045, USA, Email john.mitchell@ucdenver.edu

Eur Respir Mon 2011. 52, 248–257.
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European Respiratory Monograph;
ISSN: 1025-448x.
DOI: 10.1183/1025448x.10004710

Since its first description by LAENNEC [1] in 1819, bronchiectasis continues to be recognised as a cause of considerable respiratory illness. This disease is characterised by abnormal dilation of bronchi and is usually the result of recurrent pulmonary infections. Patients suffer from chronic cough, excessive sputum production, a progressive decline in respiratory function and haemoptysis that can be life threatening. The majority of patients can be treated medically, but those that fail or become intolerant of medical treatment may be eligible for surgical management.

Initial attempts at surgical treatment of bronchiectasis were fraught with complications. Post-operative bronchopleural fistula (BPF) and empyema occurred in $\leq 50\%$ of cases [2, 3]. Perioperative mortality was as high as 46% [3]. By 1950, the introduction of effective antibiotics in addition to improvements in surgical technique led to a dramatic decline in perioperative morbidity and mortality. Currently, surgical intervention is mainly reserved for patients with focal disease that remain symptomatic despite optimal medical management. Diffuse bronchiectasis may be treated with bilateral lung transplantation and is mainly limited to patients with cystic fibrosis (CF).

General principles

Once thought to be in decline, the incidence of non-CF related bronchiectasis is now felt to be on the rise in North America and throughout the world [4]. Patients present with recurrent pulmonary infections accompanied by copious sputum production and occasional bouts of haemoptysis. Traditional treatment paradigms have consisted of rotating schedules of targeted antibiotic therapy along with manoeuvres to promote secretion clearance. Surgical resection for bronchiectasis is reserved for patients who demonstrate disease progression despite optimal medical treatment, or become intolerant of medical therapy. Failure of such treatment represents the most common reported indication for surgical resection [5–13].

The basic concept behind surgical resection for bronchiectasis is to remove permanently damaged areas of lung parenchyma that antibiotics penetrate poorly, and thus serve as a reservoir for microbes leading to recurrent infection. Resection of diseased segments will alter the pattern of repeated bouts of infection, and provide significant symptom relief regarding cough and excess sputum production. Patients with concomitant cavitory lung disease or recurrent bouts of haemoptysis may also benefit from surgery.

The ideal candidate for surgical therapy should have truly localised disease that is amenable to anatomic lung resection. Non-anatomic (wedge) resections should be avoided if possible as this strategy frequently results in incomplete removal of the affected area. Incomplete resection has overwhelmingly been found to be the greatest predictor of symptomatic failure in these patients [5, 7, 8, 10, 12–14]. The diseased areas of lung tend to contribute little to the patient's overall lung function, thus supporting an aggressive surgical approach.

Medical therapy should always be attempted prior to entertaining the idea of surgery as the vast majority of patients will improve. There have not been any prospective randomised trials comparing the short- or long-term efficacy of medical treatment and surgery [15]. However, retrospective studies comparing patients requiring hospitalisation treated either medically or surgically found that those in the surgical group were more likely to be symptom-free at the time of follow-up. They also had fewer yearly hospital days and an overall trend toward decreased mortality [16, 17].

Pre-operative assessment

Patients with bronchiectasis most commonly present with recurrent pulmonary infections. Symptoms associated with these infections include productive cough, foul-smelling sputum, haemoptysis, fever and dyspnoea on exertion. The presence of a nonproductive cough is suggestive of upper lobe involvement. Adequate pulmonary reserve is determined through standard pre-operative pulmonary function testing and occasionally split function perfusion testing when appropriate.

The diagnosis and location of bronchiectasis is made using standard radiographic techniques. Chest radiographs are often abnormal demonstrating focal areas of consolidation, atelectasis and occasional evidence of thickened bronchi. High-resolution computed tomography (HRCT) scanning has replaced contrast bronchography as the gold standard for radiologic diagnosis of bronchiectasis. This imaging modality can detect the distribution of bronchiectatic alterations with only 2% false-negative and 1% false-positive rates [18]. Findings suggestive of the disease include bronchial dilation such that the internal diameter of the affected bronchus is greater than the accompanying bronchial artery, and a lack of bronchial tapering on sequential slices [4]. The extent of disease seen on HRCT scans has been correlated to quality of life and subsequent functional decline [19, 20]. The left lung is more commonly affected than the right and the dependent lower lobes tend to harbour more disease than the upper lobes (fig. 1). Middle lobe and lingular disease is often associated with nontuberculous

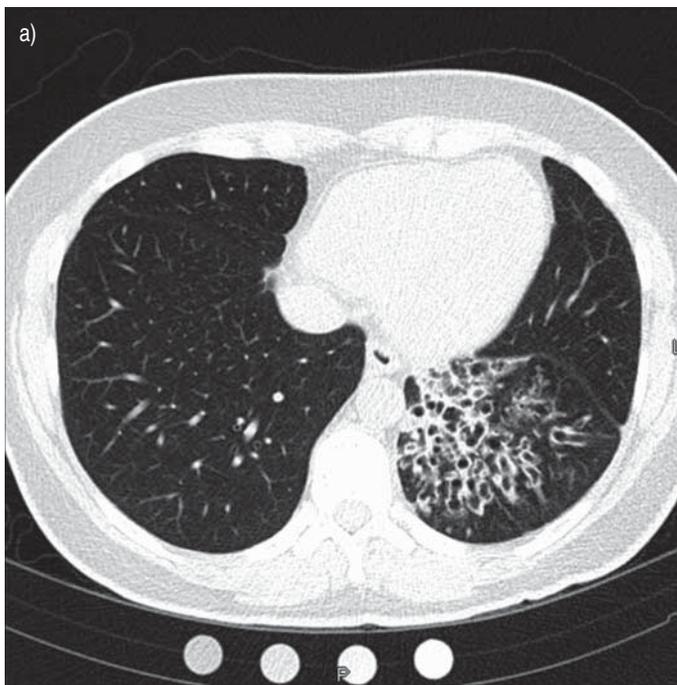


Figure 1. a) Axial and b) coronal high-resolution computed tomography images of a patient with severe left lower lobe bronchiectasis.

mycobacterial disease (fig. 2). Upper lobe involvement is suggestive of CF or allergic bronchopulmonary aspergillosis.

Bronchoscopy is performed pre-operatively, primarily to identify the offending organisms and to rule out concomitant endobronchial pathology. When patients present with active haemoptysis, bronchoscopy can be utilised to localise the source within the bronchial tree to the segmental or even subsegmental level. Sputum and bronchoalveolar lavage specimens are collected to allow identification of the microbial pathogens involved. Culture results should include *in vitro* susceptibility testing appropriate for the cultured organism to assist in pre-operative antimicrobial therapy.

Many patients who have been suffering with chronic lung infections will have lost weight and can be significantly malnourished at presentation. If this is the case, an aggressive pre-operative regimen of nutritional supplementation is recommended. This may require the placement of a nasojejunal feeding tube or a percutaneous gastrostomy. We have found that this is typically not necessary for those with limited, focal parenchymal disease.

At our institution (National Jewish Health, Denver, CO, USA), we have employed a multimodality treatment approach where patients appropriate for surgical therapy are discussed at a weekly multidisciplinary conference attended by surgeons, pulmonologists and infectious disease physicians with specialisation in respiratory infectious disease. This approach ensures that the patients receive the appropriate antimicrobial therapy and assists in

optimal timing of surgical intervention. In fact, the timing of resection should be dependent on the pre-operative antimicrobial regimen, allowing enough time to produce a bacterial nadir at the time of surgery. We feel this is critical to minimise the risk profile in the perioperative period.

Surgical technique

Anaesthesia

A standard anaesthetic technique utilised for thoracic surgical procedures is employed. Single-lung ventilation is accomplished with the use of a double-lumen endotracheal tube, or rarely a single lumen endotracheal tube with the use of a bronchial blocker. Early lung isolation may also limit dispersion of purulent secretions of uninvolved areas of the lungs. A thoracic epidural may be placed for post-operative analgesia when a thoracotomy is planned. This is usually not necessary in the event of a thoracoscopic approach, where post-operative analgesia is provided by intercostal administration of 0.25% bupivacaine at multiple levels

placed at the end of the procedure by the operative team. An arterial line and urinary catheter are placed and intra-operative fluid administration is limited as with other forms of extensive lung resection. Extubation at the end of the procedure is planned.

Surgical approach

Bronchoscopy is routinely performed prior to initiation of the surgical procedure, clearing the airway of secretions to optimise ventilation during the operation. It is important to rule out bronchial obstruction secondary to a tumour or aspirated foreign body prior to attempting resection. If severe airway inflammation is found at the time of bronchoscopy, surgical therapy may be delayed until infection control is optimised. Finally, there is always the possibility that the patient may have normal variations in bronchial anatomy which would be helpful to know prior to attempting anatomic resection.

Surgical resection for bronchiectasis is classically approached *via* lateral thoracotomy, tailored for the targeted segment or lobe. In the setting of significant disease, a full posterolateral thoracotomy may be employed. The mobilisation of muscle flaps should be accomplished at the onset of the thoracotomy, for transposition into the hemithorax later in the case after completion of the resection. An extrapleural dissection plane, if needed, may be initiated prior to placement of the rib spreader.

Several important differences exist between anatomic resection for infectious lung disease and resection for malignancy. Pleural adhesions are frequently present, and in some cases can be extensive and vascular in nature. They are typically localised to the involved segment(s) of lung, but can be scattered throughout the hemithorax. In upper lobe predominant disease, the adhesions to the overlying parietal pleura can be significant. The presence of dense adhesions can be predicted on the pre-operative HRCT, but the amount of pleural symphysis is often underestimated. Pleural adhesions can usually be divided safely with a thoracoscopic approach, often with improved visibility compared with open thoracotomy. During division of dense adhesions, care must be taken to avoid adjacent vital structures such as the phrenic nerve or great vessels.

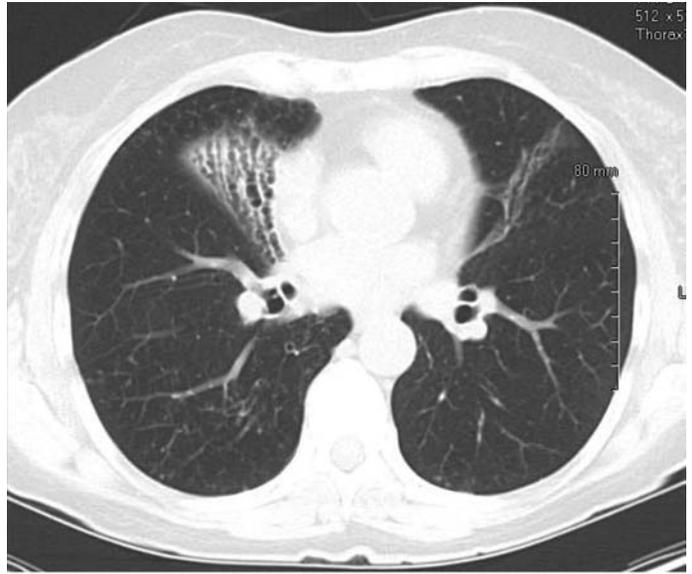


Figure 2. Axial high-resolution computed tomography image of a patient with right middle lobe and lingular bronchiectasis in the setting of nontuberculous mycobacterial disease termed Lady Windermere syndrome.

The bronchial circulation is frequently hypertrophied in cases of longstanding bronchiectasis, and particular care must be taken to assure haemostasis. Bronchial arteries should be ligated with clips if enlarged. Significant lymphadenopathy is also usually present, and in the setting of chronic granulomatous disease can make dissection at the pulmonary hilum and around vessels hazardous. When dividing pulmonary fissures with stapling devices, we advocate a line of division just on the side of the uninvolved lobe. This will assure complete resection and will avoid a staple line in infected, devitalised tissue.

The pulmonary vessels and bronchus are divided and sealed using standard stapling devices. Once the resection is completed, the diseased segment or lobe should be placed in a bag for removal, unless the thoracotomy is generous enough to avoid contamination with the specimen. In the setting of routine cases of anatomic resection for bronchiectasis, we typically do not buttress the bronchial closure with autologous tissue. The intrathoracic space is irrigated and then drained with one or two 28 French thoracostomy tubes. Portions of the specimen are sent for culture, and the remainder for pathologic analysis.

Despite the fact that the majority of published series [5–10, 12, 16] of surgery for bronchiectasis describe resection using an open (thoracotomy) approach, a video-assisted thoracoscopic (VATS) approach has been successfully employed in some studies, and is the preferred approach at our institution [21, 22]. A standard VATS technique uses two 10-mm ports and a 4-cm utility incision centred over the anterior hilum. No rib spreading is used with this technique. The two 10-mm ports are placed first with one in the seventh intercostal space in the anterior axillary line, and the other just posterior to the scapular tip. Once the feasibility and safety of a VATS approach are confirmed, the utility incision is then made. We employ a wound protector for the utility incision to avoid contamination and retract the soft tissues of the chest wall. Modifications can be made to this technique to better serve the specifics of the planned resection. Adhesions are well visualised, and are typically easier to lyse thoracoscopically, although the presence of dense adhesions or complete pleural symphysis may suggest conversion to thoracotomy. The planned resection is then completed in a manner analogous to an open approach.

Use of tissue flaps

Although not routinely performed, tissue transposition should be considered in any patient who is at increased risk for breakdown of the bronchial stump. Indications for autologous tissue coverage of the bronchial stump would include poorly controlled infection prior to surgery, resection in the setting of significant drug resistance or in the rare case of pneumonectomy for bronchiectasis [23]. We favour use of either a latissimus dorsi or intercostal muscle flap for coverage of a bronchial stump and omentum for use after a right pneumonectomy [24]. We avoid the use of a serratus muscle flap as there tend to be problems with wound healing in these characteristically thin patients related to the winged scapula following serratus transposition. Mobilisation of the latissimus is performed at the initiation of the procedure, and the muscle is transposed through the second or third intercostal space. When using an omental flap, the omentum is mobilised *via* a midline laparotomy prior to thoracotomy and tacked to the undersurface of the right hemidiaphragm for retrieval later during lung resection. Occasionally, significant intrathoracic space issues may result after resection, and may be at least partially addressed with latissimus transposition.

Post-operative management

Management of patients after surgery for bronchiectasis is similar to that of any patient who has undergone anatomic lung resection. Emphasis is placed on early mobilisation, aggressive pulmonary toilet, chest physiotherapy and nutritional supplementation. Chest tube management is routine. Appropriate antimicrobial therapy is maintained in the post-operative period and is often continued for several months, depending on the isolated organism. In patients who present

with bilateral disease and consequently are left with unilateral disease post-operatively, bronchoscopy may be necessary to help with mobilisation and clearance of secretions. Those who are treated with a thoracoscopic approach can leave the hospital as early as second or third post-operative day, while those who undergo thoracotomy often stay for up to a week.

Complications

The complications that accompany lung resection for bronchiectasis mirror those that follow lung resection for other indications with a few exceptions. Overall morbidity following resection ranges from 9% to 25% depending on the series. The most common complications after surgery for bronchiectasis include atelectasis requiring therapeutic bronchoscopy, prolonged air leak, space problems, empyema, BPF and wound infection (table 1) [5, 7–13, 22]. Absence of pre-operative bronchoscopy, forced expiratory volume in 1 second of <60% of the predicted value and incomplete resection have all been associated with the development of post-operative complications [25].

Although it is rare, the development of BPF is a source of significant morbidity, particularly after pneumonectomy. It occurs more commonly on the right side, after completion pneumonectomy, and in the setting of patients who have persistently positive sputum cultures for organisms such as multidrug-resistant *Mycobacterium tuberculosis* [22, 24]. When presented with a patient at high risk of development of BPF, prevention is paramount. Appropriate antimicrobial coverage should be given before surgery; a tension-free technique used to close the bronchus and muscle or omentum used to buttress the closure. Typical findings of a BPF after pneumonectomy include fever, cough productive of serous followed by purulent sputum, contralateral lung infiltrates and a dropping air–fluid level on chest radiograph. Management begins with prompt drainage of the infected space to prevent further damage to the remaining lung. If the BPF is diagnosed very early after resection, primary repair of the bronchial stump with rebuttoning may be attempted. When diagnosis is delayed management usually requires rib resection and creation of an Eloesser flap followed by BPF closure and subsequent Clagett procedure.

As mentioned previously, intrathoracic space problems are somewhat more common after surgery for bronchiectasis, mainly due to the fact that the remaining lung is often unable to fully expand. This leaves residual space that is usually not a problem, but can lead to development of empyema in cases that involve significant pleural soilage or parenchymal injury. Again, prevention is key and patients with these potential problems should be anticipated. Liberal use of muscle flaps to minimise the space can help prevent complications.

Table 1. Summary of morbidity after surgical resection for bronchiectasis

First author [ref.]	Prolonged air leak/space issues	Atelectasis	Empyema/BPF	Wound infection	Bleeding	Arrhythmia	Overall morbidity
DOGAN [9]	0	1.4	1.8	7.4	0	0	10.6
AGASTHIAN [5]	4.5	6.7	4.5	0	3	2.2	24.6
FUJIMOTO [10]	5.6	6.7	6.7	0	1.1	0	19.6
PRIETO [13]	5.9	0	0	0	3.4	3.4	12.6
KUTLAY [12]	1.7	2.3	1.2	0	1.7	0	11.4
BALKANLI [8]	2.5	2.9	1.7	0	1.7	0	8.8
GURSOY [11]	9.8	3.2	0	3.3	0	0	16.3
BAGHERI [7]	3.2	3.6	3.2	5.7	0	0	15.8
ZHANG [22]	2.7	2	1	0	1.1	4	16.2

Data are presented as % of all patients in each reference. BPF: bronchopleural fistula.

Table 2. Summary of patient characteristics and operative mortality after surgical management of bronchiectasis

First author [ref.]	Study period	Patients n	Age years	Males	Left-sided disease	Complete resection	Operative mortality
DOGAN [9]	1976–1988	487	25.5 (2–56)	57	64	Not stated	3.5
AGASTHIAN [5]	1976–1993	134	48 (4–89)	41	Not stated	80.6	2.2
FUJIMOTO [10]	1990–1997	90	44.7 (9–75)	49	59	83.3	0
PRIETO [13]	1988–1999	119	42.2 (11–77)	40	Not stated	90.8	0
KUTLAY [12]	1990–2000	166	34.1 (7–70)	45	59	88.5	1.7
BALKANLI [8]	1992–2001	238	23.7 (15–48)	86	Not stated	64.7	0
GURSOY [11]	2002–2007	92	38.7 (10–67)	41	74	90.2	1.1
BAGHERI [7]	1985–2008	277	34.7 (8–65)	72	70	82.7	0.7
ZHANG [22]	1989–2008	790	41.6 (6–79)	59	Not stated	89	1.1

Data are presented as mean (range) or %, unless otherwise stated.

Results

Perioperative mortality after resection for bronchiectasis is very low with contemporary rates ranging from 0% to 3.5% (table 2). Completion pneumonectomy remains a highly morbid procedure and leads to many of the deaths related to surgical treatment of this disease [5, 24]. Renal failure and advanced age (>70 years) are associated with post-operative mortality in this group of patients [22]. Mean age at the time of surgery ranges from 25.5 to 48 years and more female patients seem to be affected than male patients. Female predominance is not as consistent in reports from developing countries [7–9, 22]. The most common indication for surgical intervention is failure of medical therapy. Left-sided disease predominates and complete resection of disease is usually possible 80–90% of the time. The most commonly performed procedure is lobectomy, followed by segmentectomy, lobectomy with segmentectomy, and pneumonectomy. Very few patients undergo bilobectomy for bronchiectasis (table 3). The most common reported reason for incomplete resection is bilateral disease, although the majority of these patients should be candidates for contralateral resection at a later date. The vast majority of patients are either asymptomatic or are symptomatically improved at follow-up (table 4). Lack of symptomatic improvement is most commonly associated with incomplete resection [5, 7, 8, 10, 12, 13, 22, 25], but has also been associated with saccular bronchiectasis, history of sinusitis and tuberculous infection [10, 22].

The results of VATS lung resection for bronchiectasis have been examined in two studies in the last decade. WEBER *et al.* [26] described thoracoscopic lobectomy using five trocars with subsequent mini-thoracotomy in 76 patients with benign lung disease. 49 of the patients had bronchiectasis or

Table 3. Summary of operative procedures performed for the surgical management of bronchiectasis

First author [ref.]	Lobectomy	Pneumectomy	Segmentectomy/ wedge	Lobectomy + segment	Bilobectomy
DOGAN [9]	41.5	39	0	14.8	4.7
AGASTHIAN [5]	64.2	15.7	13.4	6.7	0
ASHOUR [6]	64.7	16.5	18.8	0	0
FUJIMOTO [10]	54.3	6.5	33.7	0	5.4
PRIETO [13]	62	8	13	14	3
KUTLAY [12]	63.4	7.5	12.2	10.5	6.4
BALKANLI [8]	79.4	5.5	2.1	13	0
GURSOY [11]	39.1	10.9	Not stated	34.8	Not stated
BAGHERI [7]	42.2	7.9	6.5	23.5	19.9
ZHANG [22]	62.9	11.3	4.7	14	7.1

Data are presented as % of total resections for each reference.

Table 4. Summary of pulmonary symptoms after surgical resection for bronchiectasis

First author [ref.]	Mean follow-up time years	% Follow-up	Asymptomatic	Symptomatic improvement	No change in symptoms/worse
DOGAN [9]	4.6	Not stated	71	Not stated	Not stated
AGASTHIAN [5]	6	76.9	45.5	22.4	9
ASHOUR [6]	3.8	100	74.1	22.4	3.5
FUJIMOTO [10]	6.1	87.8	40	33.3	14.5
PRIETO [13]	4.5	90.8	61.3	26.1	3.4
KUTLAY [12]	4.2	89.2	66.9	18.7	3.6
BALKANLI [8]	0.75	96.2	79.4	12.2	4.6
GURSOY [11]	1.3	81.5	68.5	8.7	4.3
BAGHERI [7]	4.5	100	68.5	23.8	7.5
ZHANG [22]	4.2	89.4	60.5	14.1	14.8

Data are presented as % of all patients (including those lost to follow-up) from each reference, unless otherwise stated.

chronic lung infection. The mortality rate was 0%, morbidity rate was 18.7% and 12 (15.3%) cases were converted to open procedure. Reasons for conversion to open procedure included dense adhesive disease as well as upper lobe-predominant disease. Compared with those who underwent open thoracotomy during the same time period, patients undergoing VATS resection suffered fewer post-operative complications, had less blood loss and a shorter hospital stay. More recently, ZHANG *et al.* [27] reported 52 patients who underwent VATS lobectomy using two 12-mm trocars and a 4–5-cm incision. Overall, they had similar findings with no mortality, a morbidity rate of 15.4% and conversion to thoracotomy in 13.5% of patients. Furthermore, those who were treated with a VATS approach had less morbidity and a shorter hospital stay compared with a cohort of patients who underwent open thoracotomy for resection during the same time period. Pain scores based on an 11 point pain scale were also lower in the VATS group. The conclusions of both reports were that benign lung disease, including bronchiectasis, could feasibly be resected using a VATS approach with negligible mortality and lower morbidity than with thoracotomy.

Lung transplantation

Lung transplantation in patients with bronchiectasis is only indicated for those with diffuse disease that is not amenable to segmental surgical resection and declining lung function despite maximal medical therapy. The vast majority of transplants for bronchiectasis are performed on patients with CF. Bronchiectasis develops in nearly all cases of CF and leads to chronic cough, expectoration of abnormal mucus, progressive airflow obstruction and persistent respiratory tract infections. Those with advanced bronchiectasis have poor quality of life and are at increased risk of death secondary to declining lung function. Lung transplantation has been shown to both improve quality of life and prolong survival in appropriately selected patients with advanced bronchiectasis [28, 29].

CF is the third most common indication for which lung transplantation is performed [30]. The current recommendation is for bilateral lung transplant in those with suppurative lung disease secondary to CF, even in those with heterogeneous disease. Single lung transplantation would risk contamination of the new graft by the old lung in an immunocompromised patient. Some centres will perform a single lung transplant in conjunction with contralateral pneumonectomy to avoid this risk.

The guidelines for referral of patients with CF and bronchiectasis for transplantation are listed in table 5 [30]. Additionally, patients should be considered for transplantation if there is a <50% likelihood of survival over 2 years without transplant, if quality of life is likely to be improved as a result of transplant, there are no contraindications to transplant, and they are informed of the risks and benefits of the operation and committed to proceeding with evaluation and listing. Young females with CF are considered for early referral if they suffer rapid deterioration in pulmonary

Table 5. Guidelines for lung transplantation in diffuse bronchiectasis (both cystic fibrosis and non-cystic fibrosis)

Guidelines for referral to a transplant centre	FEV ₁ <30% predicted or a rapid decline in FEV ₁ , particularly in young female patients Exacerbation of pulmonary disease requiring ICU stay Increasing frequency of exacerbations requiring antibiotic therapy Refractory and/or recurrent pneumothorax Recurrent haemoptysis not controlled by embolisation
Guidelines for transplantation	Progressive decline in lung function Oxygen-dependent respiratory failure Hypercapnia Pulmonary hypertension

FEV₁: forced expiratory volume in 1 second; ICU: intensive care unit.

status as they have a particularly poor prognosis [30]. Finally, several studies in the 1990s described infection with *Burkholderia cepacia* in prospective CF transplant candidates to be associated with significant post-transplantation infectious complications and poor outcomes [31, 32]. This has led to the presence of *B. cepacia* infection to be a relative contraindication to lung transplantation in the CF population, although some centres continue to offer transplantation therapy in this setting. More recent evidence suggests that some, but not all subspecies within the *B. cepacia* complex confer an increased risk [33].

A number of complications may occur after lung transplantation for CF and bronchiectasis, including haemorrhage, pulmonary oedema, primary graft dysfunction, anastomotic dehiscence and various infectious complications. Bacterial infections are common after transplant for bronchiectasis as numerous pathogens chronically dwell in respiratory tract secretions of these patients. Anti-bacterial regimens guided by pre- and perioperative cultures are used post-operatively in addition to standard prophylactic medications given for viral and fungal pathogens [34].

Patients with CF and bronchiectasis can expect a dramatic improvement in pulmonary function after lung transplant as well as the ability to perform activities of daily living without limitations. Long-term survival has been demonstrated in a review of 123 patients with CF who underwent either bilateral lung transplantation or bilateral lower lobe transplant from living donors [35]. Survival rates were 81% at 1 year, 59% at 5 years and 38% at 10 years. A sustained improvement in quality of life after transplantation can be expected for at least 1–3 years [34].

Transplantation for non-CF bronchiectasis is rare and specific referral guidelines have not been developed. For this reason, the guidelines used for those with CF bronchiectasis are generally used [30].

Statement of interest

None declared.

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