Pneumonectomy for inflammatory lung disease

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Abstract

Objective: Recent surgical literature has highlighted the dangers of pneumonectomy for inflammatory lung disease; therefore the assessment of the risk/benefit ratio of our departmental policy. Methods: Patients undergoing pneumonectomy for inflammatory lung disease during two 2-year periods, 1991–1992 and 1996–1997 inclusive, were retrospectively analyzed. Clinical indications for investigation and surgery, and radiographic findings were determined. Some comparisons between the two periods were drawn. Rates of morbidity and mortality were the principle outcome measures. Results: One hundred and fifty-five patients, 116 males, 39 females, with an average age of 30.2 years ranging from 1–68 years, underwent pneumonectomy for ongoing features of productive cough, haemoptysis (two emergencies) and chronic empyema all with either bronchographic or computed tomography (CT) evidence of destroyed lung. One hundred and fourteen (72%) had or had had tuberculosis at time of surgery. Histology showed bronchiectasis in 53 (34%), end-stage disease in 49 (31.6%) and active tuberculosis in 48 (30.9%). Over 90% of the patients were free of disease at discharge. Mortality was two (1.2%). Morbidity (23%) included post-pneumonectomy empyema 23 (14.8%), bleeding three (1.9%), broncho-pleural fistula three (1.9%), with wound sepsis in one (0.6%) and thoracic duct injury in one (0.6%). Three groups were identified, (1) pneumonectomy through empyema – a risk group, (2) pneumonectomy in active tuberculosis and (3) pneumonectomy in children. Twenty-three post-pneumonectomy empyemas (PPE) occurred with 21 of these following pneumonectomies through empyema (PTE), six PPEs followed 27 PTEs for active tuberculosis. Fourteen of the 21 empyemas following pneumonectomy through empyema were initially sterilized. Finally 15/23 (65%) of all PPEs were sterilized. Pneumonectomy in active tuberculosis did not carry the mortality or morbidity experienced by others. Pneumonectomy in children was remarkably uncomplicated, with one PPE occurring. Conclusions: This ongoing study shows pneumonectomy for inflammatory lung to be safe, with good results. Tuberculosis, being so common, adequate pre-operative and operative cover with anti-tuberculosis drugs may enhance results. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Pneumonectomy; Inflammatory lung disease; Pneumonectomy through empyema

1. Introduction

Recent surgical literature over the last 4 years has pointed to the dangers and difficulties in operating for inflammatory lung disease: Reed [1] highlighted these and looked to find alternative methods, such as use of midline sternotomy and abandonment of the extrapleural approach in order to reduce complications. This evoked comment [2,3]. Mortalities ranging from 2.4 [4] to 8% [1] and morbidities as high as 44% were reported and the increased risk of operating on patients for the sequelae of tuberculosis stressed [5].

Against this background I was stimulated to review our experience in a developing region where tuberculosis is rife.

2. Patients and methods

The records of 155 patients undergoing pneumonectomy for inflammatory lung disease (ILD) during two periods, January 1991 to December 1992 and January 1996 to December 1997 were retrospectively reviewed. Of these 155 patients, 116 were males (74.8%), 39 were females (25%), with a mean age of 30.2 years, ranging from 1–68 years. There were 33 children who were 10 years or younger. One hundred and twenty-nine patients underwent pneumonectomy at King George V Hospital where we lodge the chronically ill patients. Most were from poor socio-economic circumstances, their disease often long-standing, many having suffered from tuberculosis on multiple occasions with consequent immune system compromise, now further complicated in some by human immuno-deficiency virus infection (HIV). These patients present problems not generally encountered in the Western
Table 1
Histology of lungs

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No.</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronchiectasis</td>
<td>53</td>
<td>34%</td>
</tr>
<tr>
<td>End-stage lung</td>
<td>49</td>
<td>31.6%</td>
</tr>
<tr>
<td>Active tuberculosis</td>
<td>48</td>
<td>30.9%</td>
</tr>
<tr>
<td>No histology</td>
<td>4</td>
<td>2.5%</td>
</tr>
<tr>
<td>1 metastatic squamous carcinoma</td>
<td>1</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

world. [6]. One hundred and fourteen patients (72%) had or had had tuberculosis at the time of surgery, the patient numbers undergoing pneumonectomy for the various disease entities are given in Table 1, according to histology.

2.1. Pre-operative assessment

Symptomatology, accompanying co-morbid conditions and general clinical status with regard to ability to withstand pneumonectomy were assessed in all patients. Standard chest radiographs (CXR) and pulmonary function tests (PFT’s) were basic investigations supported by blood gas analysis. Bronchography and/or computerized axial tomography (CT scan) were used in all to determine the severity of disease of the affected lung, and in particular the nature and extent of disease, when present, in the contralateral lung. Occasionally ventilation perfusion scans were used to determine contributing function of the affected lung. Good functional capacity in daily activity in presence of a destroyed lung is in itself a good indicator for outcome. Simple exercise testing was used where any doubt existed.

2.2. Indications for surgery

Symptomatic patients with ongoing features of productive cough, haemoptysis, chronic empyema and recurrent chest infections with suspected unilateral pulmonary destruction confirmed by bronchography and or CT scan were considered. In some, contra-lateral disease was accepted when function was good and the major symptoms originated in the destroyed lung. The term ‘destroyed lung’ (CT evidence) often covered combined entities such as bronchiectasis, cavitation and fibrosis. Multi-drug resistance (MDR) to anti-tuberculosis therapy was used as an indication in three patients after appropriate work-up by an MDR clinic.

Prolonged preparation was necessary in some before a final decision as to suitability for surgery could be made.

2.3. Pre-operative preparation

Sputum was examined for acid fast bacilli (AFBs) and other organisms and chest infections treated with the appropriate antibiotic. When AFBs were found, surgery was deferred for 6 months, after appropriate therapy. Supravclavicular adenopathy when present was biopsied to exclude tuberculosis and unsuspected metastatic carcinoma. Bronchoscopy was performed early to determine the site and volume of pus production, to exclude foreign bodies and tumors, and to trap pus for the appropriate cultures.

Lung abscesses, usually chronic when referred, were treated according to a standard antibiotic protocol and drained when necessary. Empyemas, mostly chronic when referred, were drained initially by closed tube thoracostomy followed by open tube thoracostomy placed at the most dependent position through a rib resection. Some of these patients were fit enough for outpatient care, with chronic drainage into a colostomy bag. As drainage decreased, clinical status improved, and it was clear that the empyema space was not diminishing, and this over many months, investigation followed and the suitability for surgery assessed. Further preparation in those suitable for surgery requiring pneumonectomy through empyema (PTE) has previously been well described [7,8]. Briefly, in the absence of bronchopleural fistula the space was daily washed out with Povidone-iodine until drainage was minimal and bacterial cultures consistently showed low or absent growth. All patients were given 48 h of appropriate antibiotics and submitted to surgery. Pre-operatively all patients with a history of tuberculosis and those suspected of but not necessarily having proven tuberculosis received prolonged anti-tuberculosis therapy.

2.4. Surgery

Pre-operative bronchoscopy was carried out to ensure the presence of no more than minimal pus. Airway protection and separation was maintained by means of a double lumen tube and in most of those too small for this, a Fogarty catheter was used as a bronchus blocker. Recently the Selkors–Brown position has been frequently used with or without a bronchus blocker.

The incision of choice was a standard postero-lateral thoracotomy. Rib resection in nine, six of these for PTE was necessary where ribs were particularly imbricated. A second entry was made through a higher or lower rib space in four to deal with bleeding in one, or to facilitate dissection.

Dissection was carried out in the intrapleural plane almost exclusively, this plane being favored to the extrapleural one which led to excessive bleeding [7]. The bronchus although cut short was so fashioned as to leave a posterior flap which was closed with polypropylene (Prolene, Ethicon, Edinburgh), or polyglactin (Vicryl, Ethicon, Edinburgh) coated Polyester (Ethibond, Ethicon, Edinburgh) routinely or other materials in 4. The bronchus was tested under water at a pressure of 30 cm of water and always covered over by surrounding tissue. In three the stump was further bolstered by an intercostal muscle bundle, in one because a leak was noticed on testing and in two patients undergoing pneumonectomy for MDR tuberculosis.

Where the empyema space was entered, it was always cleaned out and in some instances an effort made to dissect out the space. The latter was rarely successful.

For HIV infected patients drapes and gowns, eye protection and double-gloving with specific handling techniques
of sharp instruments were used: no blood related accident occurred.

At completion of pneumonectomy, the chest was thoroughly washed out with povidone iodine or saline containing chloromycetin. Haemostasis was meticulously achieved. The space was drained with one underwater seal drain and the wound closed in layers. Therapeutic bronchoscopy was carried out, the bronchi having been regularly aspirated by the anesthetist during surgery. Antibiotics of choice were administered during surgery and continued post-operatively for 5–7 days whilst anti-tuberculosis therapy was continued as indicated by histology. The patient was usually extubated before transfer to the Intensive Care Unit.

2.5. Hospital stay and follow-up

Patients were retained in hospital until healed from surgery or any complications dealt with. Hospital stay could not be used as an indicator of morbidity as it was often prolonged by delay in transportation to outlying places of origin. Many patients were discharged early from the follow-up clinic. It is recognized, however, that most patients will come back in case of need [9], this being the only public sector thoracic unit in the province.

3. Results

No time constraint was placed on the occurrence of major complications relatable to the surgical procedure.

3.1. Mortality

Two patients died. One 48-year-old male died suddenly on day 11 following right pneumonectomy. The exact cause of death was not determined. Histology of the resected lung was in keeping with previous tuberculosis.

The second patient, a 57-year-old male undergoing emergency right pneumonectomy for massive haemoptysis developed a broncho-pleural fistula within one week. Following repair, he died 3 weeks later, probably of sepsis. Histology indicated active tuberculosis.

3.2. Surgical complications and morbidity

Post-pneumonectomy empyema (PPE) occurred in 23 patients, two after standard pneumonectomy (1.8%) and 21 after 47 pneumonectomies through empyema (PTE) (44%) (Fig. 1). Six PPEs followed 27 PTEs for active tuberculosis (22%), whilst 15 PPEs followed 20 PTEs (75%) for other ILDs. Using a sterilization technique based on Clagett’s procedure [10], 15 of the 23 PPEs were sterilized. Persistent PPE was managed in five by thoracoplasty (one complicated by hemiplegia), treatment undefined in one, whilst two refused surgery.

One of two completion pneumonectomies, usually a difficult procedure, carried out through an empyema and complicated by PPE, was managed by thoracoplasty after failed sterilization of recurrent PPE. Histology was that of healing tuberculosis. The second was uncomplicated, histology showing active tuberculosis and bronchiectasis.

Other major complications, neurological 3, BPF 3, vascular injury 5 and thoracic duct injury 1, occurred (Table 2). One BPF occurred after 4 months, a second was immediately recognized after surgery, repaired and led to no morbidity, whilst the third died. Bleeding, when difficult to control and requiring blood transfusion beyond the usual, or continuing post-surgery was considered a complication in seven, leading to morbidity in three. Vascular injury in five led to morbidity in one when pulmonary artery injury was such as to demand a pneumonectomy, when lobectomy was proposed. Internal thoracic artery injury required a second entry two spaces higher to deal with bleeding.

Transbronchial spill was documented in three without complication. Two patients developed significant chest infections. One major wound infection after PTE and three minor wound infections occurred.

Entry into abscess cavities, lung tissue and aspergillomata in ten, with residual lung tissue being incompletely excised in two, was complicated in one instance by post-pneumonectomy empyema where the surgeon, so concerned about contamination, performed an immediate open drainage procedure.

Decortication of lung was attempted in three, but the lung being of such poor quality pneumonectomy was performed without morbidity. One of these lungs contained metastatic squamous carcinoma according to histology.

The pericardium was entered a few times without complication and morbidity. Once the pericardium was deliberately entered to facilitate hilar dissection.

Of the 48 patients undergoing pneumonectomy in active pulmonary tuberculosis, 29 were left sided and 19 right sided pneumonectomies. Of the two emergencies, one left pneumonectomy was uncomplicated whilst the emergency right pneumonectomy died. Three of four patients with MDR tuberculosis made uncomplicated recoveries. A fourth, following PTE, developed a PPE which could not be sterilized and was satisfactorily managed by thoracoplasty.

All three HIV infected patients made uncomplicated recoveries.

PNEUMONECTOMY THROUGH EMPYEMA (PTE)

![Fig. 1. Active tuberculosis versus inflammatory lung disease.](https://academic.oup.com/wjets/article-abstract/18/4/429/420987)
recoveries (Table 3). In all, 48 patients suffered some complication or intra-operative incident, but only 38 (24.5%) suffered morbidity.

4. Discussion

Pneumonectomy for benign inflammatory lung disease (ILD) is complex [5,11,13]. It is therefore essential to have a systematic approach which will minimize the likelihood of complications, and salvage the situation when they do occur. The clinical state of patients encountered in South Africa [4,6,7,11] has been well described, and is seldom met with in the Western world.

Only symptomatic patients, amenable to surgery, with ongoing features of productive cough, haemoptysis, recurrent chest infections and chronic empyema with bronchographic or CT evidence of a destroyed lung undergo pneumonectomy [9,12]. In children, although symptoms are often denied, an abnormal chest radiograph would lead to investigation and pneumonectomy when appropriate. Whereas elective surgery in asymptomatic patients usually in a much better clinical state, may yield better results [4,13], risks of morbidity and mortality, and logistics have prevented our operating on asymptomatic patients. Pre-operative preparation, often extends over months, and aims at eliminating or controlling infections, diet related problems and managing co-morbid conditions. Preparation of the empyema space has been well described [10]. Patients sputum positive for AFBs undergo 6 months of anti-tuberculosis therapy.

Expert anesthesia is required and epidural anesthesia facilitates essential post-operative physiotherapy and recovery. Use of double lumen tubes and bronchus blockers does not entirely eliminate the risk of spill.

A standard posterolateral thoracotomy allows easy access to the awkward apex by extension to a scapula displacing incision, or a second lower thoracotomy for dissection of the stuck down lower lobe. Rib resection is useful when ribs are imbricated in relation to empyema. My experience has not caused me to consider midline sternotomy [1]; I think access is limited and complications more likely [3].

Diathermy dissection, in contrast to early experience with sharp dissection has virtually eliminated torrential hemorrhage from the chest wall with the complications of coagulopathy and the need to pack the chest. Dissection in the extra-pleural plane was abandoned because of excessive bleeding [7] but certainly I would go where it is easiest and make use of the extra-pleural plane when the risk of entering the lung is high. Sarot [14] and others [2,15] advocated this approach 50 years ago and pointed out the advantages of early access to the bronchus, avoidance of entering into lung cavities and performance of pyo-pneumonectomy. His colleagues, Selikoff and Chertkoff incurred no empyemas and no BPFs after 33 extra-pleural resections in contrast to ten PPEs and BPFs after 65 intra-pleural pneumonectomies. My own experience, not in this series, is that pyo-pneumonectomy is practical and bleeding no worse.

The hilum is unpredictable in adults but often the easiest part of the dissection. Pericardial entry for vascular control is rarely necessary but may be useful.

We believe it essential to keep the bronchial stump short, as a long stump, acting like a sump, may predispose to infec-

### Table 2
Final outcome of PPE

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Management</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPE</td>
<td>23</td>
<td>Attempted sterilization</td>
<td>15 sterilized</td>
</tr>
<tr>
<td>Neurological (hemiparesis)</td>
<td>3</td>
<td>Supportive</td>
<td>On average: reasonable quality of life</td>
</tr>
<tr>
<td>BPF</td>
<td>2</td>
<td>2 repaired, one undefined</td>
<td>1 died, 1 healed, 1 undefined</td>
</tr>
<tr>
<td>Bleeding (3 needing more than transfusion)</td>
<td>7</td>
<td>1 packed and reopened, 1 reopened, 1 prolonged support</td>
<td>Good</td>
</tr>
<tr>
<td>Vascular injury</td>
<td>5</td>
<td>4 controlled/repaired, 1 pneumonectomy</td>
<td>Good</td>
</tr>
<tr>
<td>Wound sepsis</td>
<td>1</td>
<td>Dressings and antibiotics</td>
<td>Healed</td>
</tr>
<tr>
<td>Chylothorax</td>
<td>1</td>
<td>Reopened and ligated duct</td>
<td>Good</td>
</tr>
<tr>
<td>Lung entry</td>
<td>10</td>
<td>Antibiotic irrigation and antibiotics 9, immediate open drain</td>
<td>9 healed, 1 PPE</td>
</tr>
</tbody>
</table>
tion and breakdown [11]. Perelman was able to shorten the bronchial stump at time of trans-pericardial repair for BPF and this may support the danger of a long stump [16]. With modern sutures, granulation and haemoptysis are rarely seen. Intercostal muscle flaps were satisfactorily used on two MDR patients and for repair of one BPF in contrast to chest wall muscle flaps used by Pomerantz and others when operating on MDR patients [17]. Our hand suture technique of bronchial closure was complicated by BPF in 1.9%, and compares well with a 1.3% incidence in 530 pneumonectomies (503 for cancer, 27 for ILD) [18], 12% in ILD [5] and a 2% incidence with staple closure, Forrester-Wood, CP, Hood et al, Dart et al. as quoted by Al-Kattan [18].

The use of antibiotics for 24–48 h pre-operatively, intraoperatively and post-operatively for 5 days and where contamination has occurred for 7–10 days post-operatively, we believe to be vital in preventing post-pneumonectomy empyema. This regimen includes a cephalosporin, penicillin and particularly metronidazole to counter anaerobic infection. Space and wound irrigation with povidone iodine or saline containing chloromycetin is used, as supported by animal and clinical studies [6]. Contamination by entry into lung or failure to remove all lung led to only one PPE where the surgeon had carried out an immediate open drainage procedure, in contrast to 25% PPE rate in two other comparable series [4,11].

The presence of fungal infection in six did not lead to the infective complications encountered by others [19].

Pre-operative empyema leads probably to the most frequent complications encountered after pulmonary resection [15]. Tuberculosis is a further predictor of poor outcome [5,20], the presence of sepsis adding to the risk of poor bronchial healing. Based on previous experience [8] we have continued to perform PTE as these patients lead a fairly miserable existence and outcome can certainly improve quality of life in most. With 13 (61%) of the PPEs following PTE being sterilized and there being a good result in four of the five thoracoplasties (one hemiparesis) carried out because of failure to sterilize the space, 17 (80%) of this high risk group could be determined to have a good outcome. Two patients who refused salvage surgery seemed to be coping and were relieved of their ongoing cough and sputum production. Certainly pneumonectomy in this high risk group is justified.

Our incidence of PPE after PTE is high, but is loaded by the severe concomitant lung disease and nature of the patients. Subsequent to this series when the protocol was broken, a near 100% PPE rate occurred.

### 4.1. Human immuno-deficiency viral infection

Three HIV-infected patients with a CD4 cell count of more than 400 and a clinical status no different from other patients deemed suitable for surgery [21], fulfilled our criteria for surgery (Table 4). Lack of complications in the short term in this small group is in keeping with our more recent experience of cardiac and thoracic surgery in more than 30 HIV infected patients [21]. (Table 4).

### 4.2. Pneumonectomy in children

‘Literature on pneumonectomy in children is scant’ [22]. In reviewing their experience in a population similar to ours, Conlan [23], (13 pneumonectomies) and Hewitson [24] (39 pneumonectomies) reported 0 and 5% mortality rates respectively, death being very much attributable to poor pre-operative state. No BPFs or PPEs occurred. Both stressed the importance of the prone position and protection of the airways. Our only change in the second period was to use the Sellors–Brown [25] position with or without a bronchus blocker. Although obliged to convert a planned bi-lobectomy [23] to pneumonectomy in one, dissection is generally easier than in adults and occasionally the lung may lie free within the pleural space. Mediastinal adenopathy is perhaps more prominent. With only one PPE and that being sterilized, results in these three series reflect the safety of surgery and excellent outcome. Of course, outcomes will be influenced by the severity of illness which the surgeon is prepared to accept at time of surgery [20].

### 4.3. Treatment and histology

Despite seemingly appropriate and lengthy preparation and treatment, histology of pneumonectomy specimens showed active tuberculosis in 44 non-MDR patients, according to the criteria of the Department of Anatomical Pathology, University of Natal Medical School. All these patients were operated on for the sequelae of tuberculosis. Many reports now stress the role of surgical resection in MDR tuberculosis [17,26].

### 4.4. Observations and conclusions

Many of these complex pneumonectomies were performed by registrars in training under supervision. The frequency with which the histological features of active tuberculosis were encountered in patients apparently fully treated in hospital was disturbing and must raise the question of drug resistance and drug penetration. Representative tissue now removed at surgery and cultured may give further information. One patient was sputum positive after surgery when Mycobacterium avium was cultured. Pneumonectomy in children is worthwhile. The entity of acute bronchial obstruction due to mediastinal adenopathy described by others [24,27], was not encountered. In view of the epidemic proportions that tuber-

<table>
<thead>
<tr>
<th>n</th>
<th>Pneumonectomy</th>
<th>Histology</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Through empyema (PTE)</td>
<td>Active PTB</td>
<td>Well</td>
</tr>
<tr>
<td>2</td>
<td>Through empyema (PTE)</td>
<td>Active PTB</td>
<td>Well</td>
</tr>
<tr>
<td>3</td>
<td>Standard</td>
<td>Healed PTB</td>
<td>Well</td>
</tr>
</tbody>
</table>

Table 4
HIV and pneumonectomy
cubosis has taken on in various regions of this country and the increasing numbers of MDR tuberculosis, it is important to train young surgeons expert in pulmonary resection. Sadly, the possibility of post-pneumonectomy empyema is never shed: we recently admitted a young man with PPE 20 years after pneumonectomy in childhood.

Acknowledgements

I thank Mr BJ Henderson for critical comment, and acknowledge the work of my colleagues and especially that of the nursing staff which contributed in no small measure to the outcome in these complex patients.

References

[21] Blyth DF, Buckels NJ, Sewusker R, Mitha AS. Cardiac and thoracic surgery in patients infected with the human immune-deficiency virus. Read at the combined meeting of the Royal College of Surgeons (Edinburgh) Royal College of Physicians, Glasgow, College of Medicine, Cape Town, 1999.

Appendix A. Conference discussion

Dr K. Moghissi (East Yorkshire, UK): Since presumably you are in an area of high-risk HIV positive, do you do HIV tests for all patients, or are you allowed to do HIV tests for at least the cases of TB?

Dr Blyth: The figure for our area, and we have a population of about 8.5 million, is something like one out of every three adults is now HIV-infected. We do HIV testing on all our patients except those that refuse. And sometimes those who we do it on, when we go back to them to counsel them, they would say ‘oh, I know’. We think it’s worth it. And our indication for surgery in HIV-infected patients is they must look clinically well and they must have a CD4 cell count which is above 400. On those two provisos we would operate.

Dr S. Barnard (Bradford, UK): I enjoyed your paper. Your results are excellent in this very difficult group of patients. I’ve got two questions. One is, what do you use to cover the stump? Whatever it is, what basis do you have for using that?

The second, as I understand it, you drain the empyema first with a rib resection or a big chest drain. Does that not compromise the option to go around the actual pleural space and do a pleuro-pneumonectomy?

Dr Blyth: What we cover the stump with is usually whatever we can cover it with. It’s the surrounding tissue. In those three patients that there was a bronchopleural fistula, intercostal muscle flap was made use of. Yes, there is a question about the fact that you will contaminate the area by having a rib resection site there. But again, I’m not too impressed with that, because you’re contaminating the whole area anyway because you’re starting through an empyema to start with. And we seem to be able to nicely cut out or clean out the empyema tract very well. I hope that answers your question.

Dr Barnard: I’m just not quite clear. If you drain it with the rib resection, then you’ve surely gone into that space, into the empyema cavity. How do you then say that you can do a closed operation?

Dr Blyth: No, I don’t think purely that’s a true closed operation, but it’s a considerably different operation from going in the pleural plane rather than the extrapleural plane.