



# **RADIOLOGICAL STAGING IN THORACIC ONCOLOGY**

**Professor I. Lyburn – Cheltenham General Hospital.**

The ‘tumour, node, metastasis’ system, with some newer subdivisions, attempts to define those patients who might be suitable for radical surgery or radical radiotherapy from the majority who will only be suitable for palliative measures.

Despite advances in modern imaging techniques staging is often not definitive. There may be difficulties: in defining the extent of primary tumour with the presence of collapsed or consolidated lung leading to overestimation of tumour size; assessing extent of contact or involvement with major vessels, the pleura or the pericardium; distinguishing reactive from malignant lymphadenopathy and in assigning significance to the increasing number of tiny nodules found on modern CT scanning.

The main imaging modality in staging thoracic malignancies is multi-slice CT. It may assess the primary lesion, nodes (by size criteria) and sites of potential metastatic disease including the liver, adrenal glands and skeleton in the region imaged. MRI may be used in the assessment of superior sulcus tumours to assess for local invasion.

FDG PET-CT is now almost routinely used for staging all patients with thoracic malignancy being considered for surgery or radical treatment to assess for distant metastases.

The pooled sensitivity and specificity of CT for identifying mediastinal lymph node metastases are 51% and 85% respectively and for PET scanning 74% and 85% respectively. Thus because of the potential of under or overstaging, confirmation of the status of mediastinal nodes is recommended.

Ultrasound can assess potential chest wall involvement and may be used to direct FNA of upper mediastinal or cervical nodes. Transbronchial or transoesophageal endoluminal ultrasound may direct sampling of mediastinal nodes.

Multislice CT and FDG PET/CT may also be effective in monitoring response to treatment in attempted downstaging pre surgery, diagnosing recurrent tumour and identifying the complications of treatment.

## References:

Frank C. Detterbeck, Daniel J. Boffa and Lynn T. Tanoue. The New Lung Cancer Staging System *Chest* July 2009 136:260-271

Fischer B, Lassen U, Mortensen J, Larsen S, Loft A, Bertelsen A, et al. Preoperative staging of lung cancer with combined PET-CT. *N.Engl.J Med.* 2009; 361: 32-39.

Lardinois D, Weder W, Hany TF, et al. Staging of non-small-cell lung cancer with integrated positron-emission tomography and computed tomography. *N Engl J Med* 2003; 348: 2500–07

van Overhagen H, Brakel K, Heijenbrok MW, et al. Metastases in supraclavicular lymph nodes in lung cancer: assessment with palpation, US, and CT. *Radiology* 2004; 232: 75–80

Adams K, Shah PL, Edmonds L, Lim E. Test performance of endobronchial ultrasound and transbronchial needle aspiration biopsy for mediastinal staging in patients with lung cancer: systematic review and meta-analysis. *Thorax* 2009; 64: 757-762.

NICE - Lung cancer – The diagnosis and treatment of lung cancer  
<http://www.nice.org.uk/nicemedia/pdf/CG024niceguideline.pdf>



# SURGICAL STAGING IN THORACIC ONCOLOGY

**Mr. E. Bishay – Birmingham Heartlands Hospital.**

Rational treatment decisions and ultimate prognosis of patients with lung cancer depend largely on the stage of disease at the time of diagnosis.

Surgical or invasive staging techniques will always be required as long as radiological and less invasive techniques are not 100% sensitive or specific in the pre-operative identification of patients most likely to benefit from pulmonary resection. This applies to all three components of TNM staging and no individual should be denied the chance of curative resection based on radiological or clinical findings alone.

The routine use of positron emission tomography (PET) scanning has redefined the indications for invasive staging of the mediastinum for the detection of N2 nodal involvement. Invasive staging procedures can be omitted in patients with small peripheral tumours and negative mediastinal PET images. However, in case of central tumours, PET hilar N1 disease, low fluorodeoxyglucose uptake of the primary tumour and lymph nodes  $\geq 16$  mm on CT scan, invasive staging remains indicated. PET positive mediastinal findings should always be cyto-histologically confirmed. The use of PET scans as applied to the M stage often requires cyto-histologically confirmation of distant sites of involvement.

Trans-bronchial needle aspiration (TBNA), ultrasound-guided bronchoscopy with fine needle aspiration (EBUS-FNA) and endoscopic esophageal ultrasound-guided fine needle aspiration (EUS-FNA) are new techniques that provide cyto-histological diagnosis and are minimally invasive. Their specificity is high but the negative predictive value is low. Because of this, if they yield negative results, an invasive surgical technique is indicated. They are particularly useful in restaging the mediastinum following neoadjuvant down-staging.

## Bronchoscopy

Indications: Endo-bronchial T status of central tumours.

Rule out synchronous tumours in other parts of the bronchial tree.

Vocal cord involvement signifies T4.

## Mediastinoscopy

Indications: Access to stations 1, 2, 4, and 7.

Ideally 2R, 2L, 4R, 4L, and 7 nodal stations should all be explored with a lesser but yet acceptable standard of 4R, 4L, and 7 to reduce the likelihood of false negative results. Also used to evaluate proximal main bronchi and medially based right tumours.

Sensitivity = 81% (TP/TP+FN), Specificity = 100 (TN/TN+FP), NPV (TN/TN+FN) =91%.

Complications: Morbidity 1-3%. Mortality 0.08%.

## Mediastinotomy (Chamberlain incision)

Used alone or in combination with Mediastinoscopy.

Indications: Evaluation of left nodal stations 5 & 6, central tumours close to A-P window, appropriate T4 (Pericardial involvement) staging on right.

Sensitivity 80-85% (TP/TP+FN), Specificity =100 (TN/TN+FP)

## Video Assisted Thoracic Surgery

Indications: T status in large tumours where CT can not accurately differentiate between contact and invasion. Assessment of pleural effusions and involvement (T4) including cytological confirmation.

Access to stations 5 and 6 on left and other N2 nodes not amenable to Mediastinoscopy (8, and 9).

## Thoracotomy

Indications: Final and yet important staging tool ideally when all other attempts have been exhausted. During resection, thorough intra-operative staging is essential for prognosis and need for adjuvant therapy.



## **References:**

1. Jean Deslauriers, MD and Jocelyn Grégoire, MD. *Clinical and Surgical Staging of Non-Small Cell Lung Cancer* Chest. 2000;117:96S-103S.
2. De Leyn P. et al. ESTS guidelines for preoperative lymph node staging for non-small cell lung cancer. *Eur J Cardiothorac Surg* 2007;32:1-8
3. Toloza EM, Harpole L, McCrory DC. Noninvasive staging of non-small cell lung cancer: a review of the current evidence. *Chest* 2003;123:137S-146S.
4. Toloza EM, Harpole L and F. Detterbeck, Invasive staging of non-small cell lung cancer: a review of the current evidence, *Chest* 123 (2003), pp. 157S–166S.
5. Detterbeck, FC, Jantz, MA, Wallace, M, et al Invasive mediastinal staging of lung cancer: ACCP evidence-based clinical practice guidelines (second edition). *Chest* 2007;132(suppl),202S-220S
6. Ghosh S, Nanjiah P, Dunning J. Should all patients with non-small cell lung cancer who are surgical candidates have cervical mediastinoscopy preoperatively? *Interactive Cardiovasc Thorac Surg* 2006;5:20-24
7. De Langen AJ, Raijmakers P, Riphagen I, Paul MA, Hoekstra OS. The size of mediastinal lymph nodes and its relation with metastatic involvement: a meta-analysis. *Eur J Cardiothorac Surg* 2006;29:26-29
8. Bandi, V, Lunn, W, Eberhardt, R, et al Ultrasound vs. computed tomography in detecting chest wall invasion by tumor: a perspective study. *Chest* 2008;133,881-886  
Introduction



## **STAGE SPECIFIC TREATMENT - ONCOLOGY**

**Dr. S. Chetiyawardana – Queen Elizabeth Hospital, Birmingham.**

Patients with technically operable NSCLC may not be suitable for surgery for several reasons. These include patient choice, poor lung function, comorbidities etc. Traditionally, 5 year survival figures for T1/T2 tumours treated with radical radiotherapy have been significantly inferior to surgical figures (30% v 60%), but this may be due to inadequate staging and suboptimal radiotherapy techniques. Following PET staging, modern innovative radiotherapy techniques such as IGRT, SBRT and respiratory gating modern studies show 3 year survival of 60% for T1/T2 tumours.

The non-surgical management of NSCLC has three major components: chemotherapy, radiotherapy and more recently biological therapies. Chemotherapy has established a role in the treatment of all stages except very early resectable disease (T1-2N0M0). Pre-operative chemotherapy in resectable tumours downstages disease and is associated with equivalent survival to post-operative chemotherapy. It is still considered experimental (Gilligan). Post-operative chemotherapy has conclusively been shown to confer an overall survival benefit of 5% at 5 years and this is now standard care for node positive disease (Hotta).

In advanced disease (stages IIIB and IV), chemotherapy offers palliation of symptoms, improvement in quality of life and prolongation of survival. Platinum based treatments using combinations of Cisplatin or Carboplatin and other agent remain the first line treatments of choice (Schiller). Histological and biological parameters may, in the future, guide the selection of chemotherapy and in individual patients. Evidence is emerging the multi-targeted antifolate Pemetrexed has greater efficacy in non-squamous lung tumours (Scagliotti). Docetaxel and Pemetrexed have modest activity in the second line setting in patients with good performance status (Hanna). The role of maintenance chemotherapy, although not a new concept, is still being explored using the newer cytotoxic agents such as Pemetrexed (Belani).

We are now entering the era of biological therapies. Erlotinib (Tarceva) was the first small molecule oral tyrosine kinase inhibitor to enter clinical practice and is now licensed for use as a 2<sup>nd</sup>/3<sup>rd</sup> line agent. Following the results of the IPASS trial Gefitinib (Iressa) has now been licensed and NICE approved as first line treatment for stage IIIB and IV NSCLC expressing EGFR mutation. However, combination of these agents with first line chemotherapy failed to improve outcome (Giaccone, Herbst). Recent data suggested that the degree of tumour EGFR expression may influence efficacy of these agents in selected populations (Fukuoka). The anti-VEGF monoclonal antibody Bevacuzimab did achieve a survival improvement when combined with 1<sup>st</sup> line chemotherapy, but was associated with an excess of fatal haemoptysis in squamous tumours and is therefore currently licensed only on non-squamous tumours (Sandler). Although maintenance therapy in some trials has shown early promising results, these agents have yet not been established in routine clinical practice.



# **STAGE SPECIFIC LUNG CANCER SURGERY**

**Mr. D. Waller – Glenfield Hospital, Leicester.**

There have been changes to the staging system with reclassification of T stage on basis of tumour size, other nodules and the presence of pleural effusion.

## ***Stage I (tumour <7cm, N0)***

“Lobectomy is the gold standard treatment”. This statement may be challenged in cases of stage Ia cancer or in patients with limited pulmonary function. In these cases an anatomical segmentectomy with lymph node dissection is an acceptable alternative.

## ***Stage II (any T size N1, Tumour > 7cm, chest wall, mediastinal pleura N0)***

Pneumonectomy is a disease in itself

Extended lung resections i.e bronchoplastic and angioplastic sleeve resections should be employed to avoid pneumonectomy.

### ***T3 N0/1***

Chest wall invasion is not a contraindication to resection. En-bloc rib resection and reconstruction is the treatment of choice.

Satellite nodules in the same lobe as the primary (now T3) should be resected.

### ***Stage IIIB : T4 N0/1***

Local invasion – in rare circumstances T4N0 tumours can be primarily resected with SVC / L atrial wall or vertebra.

Ipsilateral nodules – the 7<sup>th</sup> revision downstaged ipsilateral nodules in a separate lobe to the primary from M1 to T4. In these rare circumstances sublobar resection is preferable to pneumonectomy.

### ***Stage IV***

Oligometastatic disease – in rare cases where a stage I/II tumour presents with an isolated brain or adrenal metastasis initial metastasectomy can be justified if subsequent complete pulmonary resection is possible.

### ***Stage IIIA (N2 disease)***

N2 disease represents both a spectrum of disease and the interface between surgical and non-surgical treatment of lung cancer

Evidence from the staging revision suggests that single zone N2 disease has a similar prognosis to multizone N1 disease and therefore arguably should be treated primarily by surgery

Evidence from Intergroup 0139/EORTC 08941 trials suggests that multizone or unresectable N2 disease should be treated primarily by chemoradiotherapy. There may be a role for surgery if N2 is downstaged to N0 and lobectomy is possible but pneumonectomy is avoidable.



## **REFERENCES**

### ***New staging system***

Goldstraw P, Crowley J, Chansky K, Giroux DJ, Groome PA, Rami-Porta R, Postmus PE, Rusch V, Sobin L; International Association for the Study of Lung Cancer International Staging Committee; Participating Institutions.

*J Thorac Oncol.* 2007 Aug;2(8):706-14. Erratum in: *J Thorac Oncol.* 2007 Oct;2(10):985.

### ***Lobectomy in stage I disease***

Ginsberg RJ, Rubinstein LV.

*Ann Thorac Surg.* 1995 Sep;60(3):615-22; discussion 622-3

### ***Sleeve lobectomy vs pneumonectomy***

Deslauriers J, Grégoire J, Jacques LF, Piraux M, Guojin L, Lacasse Y.

*Ann Thorac Surg.* 2004 Apr;77(4):1152-6

### ***Surgery in IIIA (N2) disease***

Albain KS, Swann RS, Rusch VW, Turrisi AT 3rd, Shepherd FA, Smith C, Chen Y, Livingston RB, Feins RH, Gandara DR, Fry WA, Darling G, Johnson DH, Green MR, Miller RC, Ley J, Sause WT, Cox JD.

*Lancet.* 2009 Aug 1;374(9687):379-86.

van Meerbeeck JP, Kramer GW, Van Schil PE, Legrand C, Smit EF, Schramel F, Tjan-Heijnen VC, Biesma B, Debruyne C, van Zandwijk N, Splinter TA, Giaccone G; European Organisation for Research and Treatment of Cancer-Lung Cancer Group.

*J Natl Cancer Inst.* 2007 Mar 21;99(6):442-50.

### ***Extended resection in T4 tumours***

Yildizeli B, Dartevelle PG, Fadel E, Mussot S, Chapelier A.

*Ann Thorac Surg.* 2008 Oct;86(4):1065-75; discussion 1074-5.

### ***Oligometastatic disease/Synchronous tumours***

Van Schil PE, Hendriks JM, Carp L, Lauwers PR.

*Expert Rev Anticancer Ther.* 2008 Dec;8(12):1931-8.

Riquet M, Cazes A, Pfeuty K, Ngabou UD, Foucault C, Dujon A, Banu E.

*Ann Thorac Surg.* 2008 Sep;86(3):921-6.



# **BULLOUS DISEASE: PRIMARY PNEUMOTHORAX**

**Mr. M. Cowen – Castle Hill Hospital, Hull.**

Pneumothorax is air in the pleural space. Primary pneumothorax occurs in otherwise healthy patients without any lung disease with an incidence of up to 28/100,000 per year for males. There is a strong association with smoking and despite no underlying lung disease sub pleural blebs and bullae are likely to play a role and are present in 90% of patients at surgery and 80% of patients on CT scan,

It is not felt that physical activity causes a pneumothorax. Most cases are symptomatic but nearly half the patients wait more than 2 days with symptoms before seeking medical attention. Clinical history and physical examination usually suggest the presence of a pneumothorax but are not reliable indicators of pneumothorax size. Diagnosis is normally established by plain chest X-ray. Size of the pneumothorax is divided into “small” or “large” depending on the presence of a visible rim of <2cm or >2cm between the lung margin and the chest wall (2cm approximates to a 50% pneumothorax).

Patients with a small pneumothorax and minimal symptoms do not require hospital admission but are discharged with appropriate advice. Symptomatic patients who require admission require active intervention, observation alone is inappropriate. Supplemental high flow oxygen should be given. Simple aspiration is recommended as first line treatment for all primary pneumothoraces requiring intervention (A). If more than 2.5L aspirated or the procedure fails a second aspiration should now only be considered if there were technical difficulties and an intercostal drain should be inserted. Pneumothoraces which fail to respond within 24 hours should be referred to a respiratory physician(C). Chemical pleurodesis should not be considered after a first time uncomplicated primary pneumothorax. Chemical pleurodesis with tetracycline can be recommended for recurrent primary pneumothorax when surgery is not an option.

With the statistical and perceived risk of recurrence the accepted indications for surgery are:

- Second ipsilateral pneumothorax
- First complicated pneumothorax
- Bilateral spontaneous pneumothorax
- Persistent air leak
- Spontaneous haemothorax
- Professions at risk
- Pregnancy

Surgical treatment is based on two principles, firstly resection of the cause of the air leak to remove the underlying defect and secondly create pleural symphysis.

## References

1. Management of spontaneous pneumothorax: British Thoracic Society pleural disease guideline 2010 Thorax 2010 ;58(suppl 2) ii18-ii31
2. Editorial comment: Management of primary spontaneous pneumothorax: a plea for a mini-invasive approach
3. Sedrakyan, A. et al. Video assisted thoracic surgery for the treatment of pneumothorax and lung resections: systematic review of randomised clinical trials. BMJ 2004 , doi:101136/bmj.38243.440486.55



## **SECONDARY PNEUMOTHORAX**

**Mr. M. Kalkat – Birmingham Heartlands Hospital.**

A pneumothorax may be spontaneous or secondary to traumatic, diagnostic or a therapeutic procedure. A spontaneous pneumothorax can be “primary”, occurring without known aetiology or clinical evidence of an underlying disease or “secondary” to a disease process that predisposes to pneumothorax.

In 20% of patients with spontaneous pneumothorax the event is related to underlying localized or generalized pulmonary disease process. The annual incidence of secondary pneumothorax is 6.3 per 100,000 population in males and 2.0 per 100,000 population in females.

The various causes of secondary pneumothorax are

1. Airway disease  
Bullous disease, COPD, Asthma, Cyst, Pneumatocele, Cystic fibrosis
2. Interstitial disease  
Idiopathic pulmonary fibrosis, Eosinophilic granuloma, Sarcoidosis, Tuberos sclerosiis, Connective-tissue disease (Rheumatoid arthritis -causes pyopneumothorax, Ankylosing spondylitis, Polymyositis and dermatomyositis, Scleroderma, Marfan’s syndrome, Ehlers–Danlos syndrome)
3. Infections  
Anaerobic, Staphylococcal, Gram –ve pneumonias, Lung abscesses, Tuberculosis, Nocardiosis, PNP (6% of patients with AIDS)
4. Neoplasms  
Primary and Metastasis (sarcomas in particular)
5. Oesophageal perforation
6. Traumatic
7. Iatrogenic  
Mechanical ventilation 3-4%, Thoracentesis, pleural biopsy, CVP line insertion, Nasogastric tube, endoscopic procedure, laparoscopic surgery, inappropriately manage drains
8. Catamenial pneumothorax
9. Lymphangiomyomatosis (LAM)
10. Inhalation and IV drug use – marijuana and cocaine

Most common cause of secondary pneumothorax is COPD. The second peak of pneumothorax occurs between ages of 45 and 65 years of age and is usually secondary to underlying lung pathology. Sign and symptoms often resemble the underlying disease and hence it may go unnoticed. The secondary pneumothorax can precipitate respiratory failure as the patients are older and usually have compromised lung function. Pneumothorax should always be excluded in the case of decompensated COPD or cystic fibrosis. The mortality rate in patients with severe COPD reaches 16 – 17%.

Treatment:

The aim of treatment remains alleviation of symptoms, treat underlying cause, recognize complications and prevent recurrences. Most of the patients with secondary pneumothorax are dealt non-surgically, as compared to primary pneumothorax. The treatment is individualized depending on the underlying cause.



# TUBERCULOSIS

Mr. S. Barnard – Freeman Hospital – Newcastle upon Tyne.

## Background

Tuberculosis is one of the oldest diseases known to man, with skeletal evidence appearing about 8000 years ago, and written descriptions of the infection from over 2500 years ago. Its first appearance coincides with mans transition from hunter gatherer to domesticator of animals, and links through *Mycobacterium Bovis* have been postulated on that basis, but gene analysis has cast doubt on that hypothesis. It is *Mycobacterium Tuberculosis* that causes the greatest burden of disease in the past and at present. It is a disease of poverty.

## Epidemiology

Worldwide the incidence of tuberculosis is 8.8 million a year (141/100,000) with about 1.6 million deaths. Africa has the highest incidence with 343/100,000. The number of cases in the UK is much lower, with 8113 cases in 2006, an incidence a magnitude lower (14/100,000) than the worldwide incidence. The situation now seen in Africa was similar to that in this country in 1880, when 11% of all deaths were caused by tuberculosis with an incidence of the disease in that year of 308/100,000. Currently in the UK, at least 40% of the cases are from the London area, with the Brent area having an incidence 8 times that of the UK as a whole (114/100,000)

The disease has declined through the latter half of the 20<sup>th</sup> century but increased since 1987 to remain a major world health problem. Some of this is due to the AIDS epidemic, and in subSaharan Africa, 31% of new adult TB cases were in patients with preexisting HIV (2002 figures).

Risk factors for the disease include overcrowding (including prisons), immunosuppression, certain ethnic groups and alcoholism, but HIV has become the strongest risk factor for the disease. Being a contagious disease, contact with a known case of TB is a strong risk factor: it is estimated that a patient with active TB will go on to infect 20 patients.

Molecular studies on strains of *Mycobacterium Tuberculosis*, suggest that, in high incidence areas, exogenous reinfection is a significant contributor to disease, in addition to reactivation of latent disease.

## Microbiology

Gram positive curved rods, but stain poorly with this method. Non sporing and aerobic. They are acid fast: retaining arylmethane dye even when treated with acid. There are 62 lineages within the MTB group, e.g .the Beijing subtype, of interest particularly to community epidemiologists. The infection is usually passed on via droplets.

## Pathology

Primary infection occurs in the alveoli, with macrophages ingesting the bacilli. The macrophages undergo transformation to multinucleated giant cells and in the majority (90%) of primary infections, healing takes place. In 5-10% the infection persists and can spread to the lung (producing miliary tuberculosis) and other organs including bone. Even if healing takes place the disease may remain dormant and a reactivation may occur if the balance of tubercle growth against destruction by cell mediated immunity is altered e.g. by immunosuppression.

## Clinical Presentation

Cough, fever and weight loss, particularly in conjunction with one of the risk factors mentioned above or a contact history with a known case of tuberculosis, is suspicious of tuberculosis infection. Sputum smear staining, the Tuberculin skin test and sometimes Interferon  $\gamma$  release assay are used to confirm the diagnosis.

## Treatment

Standard treatment is 6 months of combination (usually quadruple) treatment with Rifampicin, Isoniazid, Pyrazinamide and Ethambutol. Compliance is a major issue in the developing world and amongst some of the high risk groups. Under very favourable conditions (compliance, no drug resistance) 90% of patients can be cured of their tuberculosis<sup>1</sup>.



## Surgery

Surgery for tuberculosis can be considered under 4 headings:

1. Diagnosis
  2. Treatment to eradicate infection
  3. Treatment for complications
  4. Management of spaces-usually from collapse treatment in the past.
1. **Diagnosis**-This is probably most frequently performed in the UK by mediastinoscopy. Mediastinal widening noted on a chest X-ray is further investigated by CT and enlarged nodes demonstrated. There is usually a contact history or the patient is in a high risk group. In a study from Lille, 6% of isolated mediastinal lymphadenopathy was due to tuberculosis (the majority were sarcoid). Lung biopsy and pleural biopsy are occasionally used to establish a diagnosis of tuberculosis-a study from Nagano in Japan found 5% of SPN to be due to tuberculosis.
  2. **Eradication**- This includes failed medical treatment of “standard” tuberculosis, eg through poor compliance and the more common indication of Multiple Drug Resistant (MDR) tuberculosis, (defined as resistance to Isoniazid and Rifampicin) which has a low incidence in the UK of 0.7%<sup>1</sup> (in previously untreated patients) but is higher in previously treated cases. It is a huge problem, in numeric and percentage terms, in certain parts of the world such as Eastern Europe, where there may be 30,000 new patients/year with TB, 10% of these cases have MDR TB<sup>2</sup>. These patients would be treated medically with second line antibiotics but a significant number come to surgery.

The surgical principles include:

1. There should be localised disease
2. Fitness for surgery: preoperative sputum negativity preferred especially in MDR TB
3. Wide resection including pneumonectomy
4. Care and reinforcement of the bronchial stump: pneumonectomy BPF rate of up to 25%
5. Postoperative treatment with antibiotics (second line therapy) for up to three years in the case of MDR TB.

The surgery can be technically taxing due to fibrosis and obliteration of fissural planes<sup>4</sup>. In MDR TB, there are now a number of case series of lung resection, with low mortality and excellent outcomes with conversion to sputum negativity in 85-90%<sup>6</sup>.

Most recent surgical figures from SCTS data in 2002: there were 37 resections for tuberculosis, of which 6 were pneumonectomy, three combined with thoracoplasty.

3. **Management of spaces**-usually from collapse treatment in the past. Various materials used to effect collapse of the lung which promoted healing. Although artificial pneumothorax was popular, surgical methods such as thoracoplasty were widely used. A more straightforward operation was plombage, the insertion of foreign materials to aid collapse of the lung. Lucite balls were preferred and are made of methacrylate. However they could erode through the chest wall or into mediastinal structures and removal may be required. There are very few patients with plombage balls in situ as it fell out of favour at the beginning of the Streptomycin era around 1950<sup>5</sup>.



Management of the residual space left from artificial pneumothorax can be difficult, should the space become infected, and if simple drainage fails to improve the situation, myoplasty or even thoracoplasty may need to be considered.

4. **Treatment of complications**-eg (i) bronchostenosis from fibrosis: dilatation and stenting may be required.

(ii) Lobectomy for Aspergillus infection, bronchiectasis

(iii) Haemoptysis-usually erosion into a bronchial artery.

Embolisation can be tried.

(iv) Bronchial obstruction by nodes-can respond to steroids

(v) Pericarditis-1-4% get effusions which may require a pericardial window or even full pericardectomy: however, initial management is medical unless there is tamponade.

(vi) Empyema-for small effusions, medical treatment is indicated. Drainage, including rib resection may be required-a decortication may not be successful due to the diseased underlying lung.

## **References**

1. Surveillance of tuberculosis in Europe-EuroTB  
[www.invs.sante.fr/publications/2007/eurotb\\_2005/eurotb2005.pdf](http://www.invs.sante.fr/publications/2007/eurotb_2005/eurotb2005.pdf)
2. Zignol, M Hosseini R Wright, A et al "Global Incidence of Multidrug-Resistant Tuberculosis" Journal of Infectious Disease 2006; 194:479-485
3. Mehran RJ and Deslauriers J "Tuberculosis and atypical mycobacterial disease" In Pearson FG, Cooper JD, Deslauriers J, Ginsberg, R Hiebert CA, Patterson GA and Urschel HC (eds): Thoracic Surgery Pennsylvania USA Churchill Livingstone 2002
4. Goldstraw P "The surgery of tuberculosis" In Davies PDO Clinical Tuberculosis Arnold Publishers London 4<sup>th</sup> edition 2008
5. Weissberg, D and Weissberg-Kasav D "Foreign bodies in pleura and chest wall" Ann Thor Surg 2008; 86: 958-961
6. Somocurcio JG, Sotomayor A, Shin S, Portilla S, Valcarcel M, Guerra D, Furin J Surgery for patients with drug-resistant tuberculosis: report of 121 cases receiving community-based treatment in Lima, Peru Thorax 2007;62:416-421



## **Lung Abscess**

### **Incidence/Epidemiology**

Accurate statistics on the incidence of lung abscess are difficult to obtain but HES data suggests about 500-1000 cases per year or 1-2/100,000 population. The M:F ratio is 2:1.

### **Classification**

Sometimes classified into primary or secondary.

Primary: as a consequence of necrotising infection  
Following aspiration (infected oral secretions/gastric contents)  
In immunosuppressed patients

Secondary bronchial obstruction including foreign body  
Pulmonary infarct (<5% of infarcts become an abscess)  
Lung diseases-Sarcoid, Wegener's  
Bacteraemia

Lung abscess may be acute or chronic, after 6 weeks. A lung abscess is >2cm in diameter, smaller abscesses are classified as necrotizing pneumonia.

### **Pathophysiology**

Most cases occur in the apical segments of the lower lobes or the posterior segments of the upper lobes, especially on the right. Necrotising infection (*Klebsiella*, *Staph aureus*, rarely *Strep. Pneumoniae*,) may account for 40% of lung abscesses. The most common cause is said to be aspiration of infected oropharyngeal secretions. Therefore, poor gingivodental hygiene is a risk factor. Impaired consciousness (general anaesthesia, high alcohol intake) and conditions that predispose to aspiration, such as oesophageal diverticula and carcinoma (the latter sometimes through tracheal fistulisation), are also risk factors. In one study of 252 cases from Brazil, alcohol was implicated in over 70% of patients with lung abscess. In cases of aspiration, anaerobes predominate and may include *Fusobacterium*, *Bacteroides* and *Peptostreptococcus* species. Most are mixed.

### **Clinical**

The onset may be insidious and over weeks. Cough, productive of a foul sputum is a suspicious symptom, particularly in the setting of the risk factors mentioned. Chest pain, malaise and weight loss may occur. Haemoptysis occurs in 15% and may be life-threatening. About 10% are complicated by empyema formation. Clinical examination may reveal finger clubbing, poor gingivodental hygiene, and rarely amphoric breath sounds. Cachexia may be evident.

### **Investigation**

The chest X-ray shows a cavitating lesion with an air-fluid level. CT is helpful, especially in ventilated patients, where the air-fluid level is less easy to demonstrate. Bronchoscopy is advised to rule out an obstructing lesion such as a carcinoma or foreign body. Secretions and lavage specimens may give the diagnosis.

On CT the question arises: is the fluid level from an empyema or lung abscess? Empyema tends to have smooth edges and forms an obtuse angle with the chest wall rather than an acute angle in lung abscess-the adjacent lung (vasculature, bronchial markings) are more compressed in an empyema. Fine needle aspirate can produce a high yield of the responsible organisms and may be followed by percutaneous drainage in suitable cases.

### **Differential diagnosis**

1. Cavitating carcinoma-more likely if no risk factors and statistically. Carcinomas tend to be thicker walled. Pyrexia much less common.
2. Tuberculosis
3. Infected bulla
4. Empyema-see above
5. Hydatid-eosinophilia may be present
6. Wegener's granulomatosis
7. Fungi-aspergilloma



## Treatment

The mainstay is antibiotics, Clindamycin and Metronidazole, intravenously at first and continued for 6 weeks. The majority (90%) respond in the first two weeks to this treatment.

Failure of antibiotic treatment, larger abscesses, and contamination of the contralateral side should prompt consideration of percutaneous drainage or surgery. The percutaneous route is usually performed with the Seldinger technique under CT guidance.

Surgery is reserved for a small number of cases (5% or less, 29 cases in UK 2002). Indications are

- (i) Failure of medical treatment
- (ii) Massive haemoptysis
- (iii) Inability to exclude carcinoma

Lobectomy is the operation of choice. Early control of the bronchus is recommended to prevent contamination of the contralateral lung.

## Prognosis

Mortality in the preantibiotic era was 30-60%. Now it should be in the region of 5%, although higher in the immunosuppressed population.

## References/Further reading

1. Moreira JS, Camargo JJ, Felicetti JC et al Lung abscess: analysis of 252 consecutive cases diagnosed between 1968 and 2004. *J. bras. pneumol.* 2006 **32**:136-143.
2. Davis B, Systrom DM. Lung abscess: pathogenesis, diagnosis and treatment. *Curr Clin Top Infect Dis.* 1998; 18:252-73.

## Aspergillosis

### Mycology

*Aspergillus* is a genus of saprophytic fungi totalling over 200 species, 38 of which are known to cause disease. *Aspergillus fumigatus* causes most human disease, but *A. niger* and *A. flavum* are also encountered. They were first described in 1729 by Micheli, and named after the aspergillum or holy water shaker. They are widespread in nature, being found on foods, soil especially compost heaps, in water (tanks, swimming pools, heating systems) and grow on damp walls (mildew). The spore elongates and forms a hyphae (filament) which is capped by the conidiophores; these are fed by the hyphae until they are mature and released as new spores of ~2µm diameter. It is estimated that 100-200 spores are breathed in each day. Spore levels increase with building demolition, of practical importance in hospitals with immunosuppressed patients such as post transplant.

### Incidence

It is difficult to give a figure for true incidence. One study suggests 11% of TB cavities become colonised by an aspergilloma. SCTS figures from 2002 suggest resection for aspergillus is rare, 12 cases that year.

### Pathophysiology/Clinical

Three forms of disease are encountered:

- (i) Allergic Bronchopulmonary Aspergillosis (ABPA)-an allergy to the spores, that usually occurs on a background of asthma or cystic fibrosis-up to 10% of CF patients may be affected. Raised IgE and *Aspergillus* precipitins may be present. Clinically the patients present with cough, with production of brown plugs of sputum with increased wheeze. Steroids, sometimes with voriconazole are used to control the disease.
- (ii) Invasive aspergillosis is almost exclusively confined to immunosuppressed patients, especially transplant recipients. It is the commonest pulmonary fungal infection in this group of patients and is a significant problem numerically, with 8% of bone marrow transplant patients and 11% of lung transplant patients developing the disease. HIV patients are also susceptible but at lower risk (3%). Lung infiltrates occur, and can lead on to cavitation.



The fungal colonies invade blood vessels, causing thrombosis and local haemorrhage, (seen on CT as the “halo sign”) and entry to these vessels allows dissemination to other organs eg brain, liver to occur. Bronchoalveolar lavage or even thoracoscopic lung biopsy may be required to establish the diagnosis. Voriconazole is recommended first line treatment. The mortality is high, around 50% and is particularly high (c.90%) in bone marrow transplant recipients and those with brain involvement.

(iii)Aspergilloma usually occurs as a colonisation of a pre-existing cavity (TB, sarcoid, lung abscess, cyst etc). It is sometimes classified into simple and complex following the classification of Belcher and Plummer. Simple aspergillomas develop in a cyst lined by ciliated epithelium, whereas complex ones arise in a cavity due to pre-existing disease, they are thicker with CT evidence of surrounding parenchymal disease, usually tuberculosis. The majority (80-90%) are the latter. Although the disease may be asymptomatic, most patients present with haemoptysis (80-90%) which may be life threatening. Almost all have positive *Aspergillus* precipitins. Chest X ray may show a (typically apical) mass surrounded by a crescent of air (Monod’s sign). Most progress, even if initially asymptomatic although a few regress and heal.

Series comparing medical treatment and resection, show a benefit for surgery. Systemic antibiotics and intracavernous instillation of antifungals have variable results. Surgery is controversial in asymptomatic patients and in the very ill, it carries a high risk. Haemoptysis is the main indication. The operation can be technically challenging due to dense adhesions. Air leak and bronchopleural fistulas are a particular complication-the latter may require thoracoplasty to treat as the underlying residual lung may be poorly expansile due to disease.

### References/Further reading

1. **Belcher** JR, **Plummer** NS “Surgery in bronchopulmonary aspergillosis”. (1960) Br J Dis Chest. 54:335-341.
2. “**Aspergillosis**” In Pearson FG, Cooper JD, Deslauriers J, Ginsberg, R Hiebert CA, Patterson GA and Urschel HC (eds):Thoracic Surgery Pennsylvania USA Churchill Livingstone 2002
3. [www.aspergillus.org.uk](http://www.aspergillus.org.uk) this is an excellent resource based at Wythenshawe Hospital in Manchester and provides all the information anyone could require about this fungus.
4. Riscilli, BP and Wood KL Noninvasive Pulmonary *Aspergillus* Infections Clinics in Chest Medicine 2009: 30;315-335
5. Walsh TJ, Anaissie EJ, Denning DW, et al. Treatment of aspergillosis: clinical practice guidelines of the Infectious Diseases Society of America. *Clin Infect Dis*. 2008;46:327-360. These recent guidelines are available over the internet and are strong on medical care of patients with aspergillosis but also cover some of the surgical issues in aspergilloma and resection in invasive aspergillosis.



## **INTERSTITIAL LUNG DISEASE**

**Dr. J. Reynolds - Birmingham Heartlands Hospital.**

The interstitial lung diseases are a group of conditions characterised by varying degrees of inflammation and fibrosis and can involve the interstitial tissues, the airways and air spaces. The modern classification is based on a paper published by a joint working group of the ATS and ERS and published in 2002. Key to managing these patients is a multidisciplinary approach and this was re-emphasised in the more recent BTS guidelines.

The terminology can be very confusing. The most commonly encountered entity is the clinical condition which is known in the UK as “cryptogenic fibrosing alveolitis” and in the USA as “idiopathic pulmonary fibrosis”. The underlying pathological process in this condition is known as “usual interstitial pneumonia” or UIP. Unfortunately, the terms for the clinical entity and pathological process are often erroneously used as if they were interchangeable. UIP results in a classical appearance at pathological examination and on a high resolution CT of the lungs – sub-pleural reticulation which is lower zone predominant and usually associated with honeycombing and traction bronchiectasis. Thus patients with a classical clinical presentation of idiopathic pulmonary fibrosis and an HRCT which shows a classical UIP pattern do not need a surgical biopsy. Patients whose imaging and/or clinical presentation is less classical may require a surgical lung biopsy, assuming that less invasive tests such as serology and sometimes bronchoscopy with lavage have not provided a diagnosis. At our institution this decision is made at an interstitial lung disease panel meeting with core members of a physician, radiologist and pathologist and with a thoracic surgeon also in attendance. The meeting will decide on the need for a biopsy and also advise on the area of lung most likely to yield diagnostic tissue.

### **References:**

ATS/ERS International Multidisciplinary Consensus Classification of the Idiopathic Interstitial Pneumonias. *Am J Respir Crit Care Med* 2002; 165: 277-304.

Bradley B et al. Interstitial lung disease guidelines: the BTS in collaboration with the Thoracic Society of Australia and New Zealand and the Irish Thoracic Society. *Thorax* 2008; 63 v1-v58.

Rosewarne D, Reynolds JH, Trotter SE, Burge PS. The idiopathic interstitial pneumonias – a survival guide. *Imaging* 2008; 20: 289-302.



# **SURGERY FOR INTERSTITIAL LUNG DISEASE**

**Mr. R. Steyn – Birmingham Heartlands Hospital.**

Interstitial lung disease guideline: the British Thoracic Society in collaboration with the Thoracic Society of Australia and New Zealand and the Irish Thoracic Society  
A U Wells, N Hirani and on behalf of the British Thoracic Society Interstitial Lung Disease Guideline Group, a subgroup of the British Thoracic Society Standards of Care Committee, in collaboration with the Thoracic Society of Australia and New Zealand and the Irish Thoracic Soc  
Thorax 2008;63;v1-v58

## Surgical lung biopsy in interstitial lung disease

- In prospective and retrospective studies, surgical lung biopsy has been shown to yield pathological diagnosis in 37–100% of cases.
- Two key considerations impact upon the decision to pursue a surgical lung biopsy in a patient with interstitial lung disease: (1) the risk associated with a surgical approach and (2) the recognition that histological assessment in interstitial lung disease has limitations and that the multidisciplinary integration of clinical and HRCT data, perhaps with the addition of transbronchial biopsy or bronchial lavage, is often sufficient to yield a confident diagnosis.
- Surgical lung biopsy, when required, should be performed before the initiation of treatment.
- A confident pathological diagnosis of interstitial pulmonary fibrosis or the other interstitial pneumonias can only be made if a surgical lung biopsy is obtained.
- A confident clinical diagnosis of interstitial pulmonary fibrosis can be reliably made in the presence of characteristic HRCT and clinical findings.
- If a surgical biopsy is performed in cases of suspected interstitial pneumonia, more than one biopsy specimen must be taken from more than one site, preferably from different lobes.
- Multiple multilobe lung biopsies are technically easier by video-assisted thoracoscopy (VATS) than by open lung biopsy.
- VATS is also associated with less early postoperative pain than open lung biopsy.
- It is recommended that the precise biopsy sites are based on HRCT appearances.
- In patients with suspected IIP, areas of intermediate abnormality or comparatively normal lung adjacent to areas of established honeycombing should be targeted with the specific aim of identifying UIP if present.

## Referral for lung transplantation

- Patients should fulfil established selection criteria for transplant, thus generally excluding those over the age of 65 years and/or those with significant comorbidity.
- Referral to a transplant centre should be made if the disease is advanced (TLCO ,40% predicted) or progressive (>10% decline in FVC or >15% decline in FVC during 6 months of follow-up).



# LUNG VOLUME REDUCTION SURGERY (LVRS) FOR END STAGE

## EMPHYSEMA

Mr. R. Page - Liverpool Heart and Chest Hospital.

### Pathophysiology of Emphysema:-

Pathology	Physiological result	Clinical Features
Parenchymal loss	Alveolar loss □ □ surface area	□ pO <sub>2</sub> , □ pCO <sub>2</sub> , □ DLCO,
	□ Elastic recoil > Bronchiolar compression	□ FEV <sub>1</sub> , □ resistance, □ work □ FVC, dyspnoea
Enlarged air spaces	Hyperinflation > uneven V/Q	□ pO <sub>2</sub> , □ pCO <sub>2</sub> , □ RV, □ DLCO
	Chest > Unfavourable hyperexpansion mechanics	□ FEV <sub>1</sub> , □ pCO <sub>2</sub> , dyspnoea

### Surgical Technique

Resection of strip of most severely affected lung (70% of volume of upper lobe)  
Shape residual lung to conform to thoracic cavity  
Buttress staple / suture lines to reduce air leaks  
Bilateral via sternotomy versus unilateral VATS

### Mechanism of Action

1. Reduced airways resistance (increased outward traction)
2. Improved ventilation / perfusion matching
3. Improved chest wall mechanics (ribs less horizontal, diaphragm more domed)

### Physiological benefits

1. Improved gas exchange
2. Improved gas flows
3. Reduced work of breathing
4. Subjective improvement in dyspnoea

### Ideal candidate

“Pure” emphysema (dyspnoea, not sputum or bronchospasm = “pink puffer”)  
Hyperexpansion - clinical and radiographic, large residual volume, reasonable preservation of DLCO  
Upper zone disease (CT + VQ scan assessment)  
Absence of other disease (PA hypertension, ischaemic heart disease, diabetes, etc)  
Significant limitation due to dyspnoea

### NETT (National Emphysema Treatment trial. Ann Thorac Surg 2006;82:385-7)

1218 patients randomised to surgery or medical treatment  
End-points = long-term survival and quality of life

Results:-

- Upper lobe disease, poor exercise capacity:-
  - LVRS better for survival and QOL
- Upper lobe disease, good exercise capacity:-
  - LVRS better for QOL, survival unaffected
- Non-upper lobe disease:-
  - Medical therapy better

### Other References

1. Results of 150 consecutive bilateral lung volume reduction procedures in patients with severe emphysema  
Cooper JD et al J Thorac Cardiovasc Surg  
1996;112:1319-29
2. Long term survival after thoracoscopic lung volume reduction: a multiinstitutional review  
Naunheim KS et al Ann Thorac Surg 1999;68:2026-32
3. A randomised trial comparing lung-volume reduction surgery with medical therapy for severe emphysema  
National Emphysema Treatment Trial Research Group N Engl J Med 2003;348:2059-73



# **ADVANCES IN THE TREATMENT OF THYMIC MALIGNACIES**

**Professor F. Detterbeck – Yale University, U.S.A.**

Thymic malignancies are relatively uncommon, and have been characterized more by repeated dogma than actual data. In the last decade much data has been accumulated, but developing a composite body of knowledge is limited by differences in definitions and outcomes. Nevertheless, a clearer picture of management of these patients is emerging. Review of the state of affairs is useful not only for this field, but also because it provides insight into general issues, such as advances in statistics, clinical research methods and outcomes analysis.



## **VATS LOBECTOMY**

**Mr. W. Walker – Royal Infirmary of Edinburgh.**



# **CHEST WALL RESECTION AND RECONSTRUCTION**

**Professor F. Detterbeck – Yale University, U.S.A.**

A variety of different primary and secondary malignant chest wall tumors are treated with chest wall resection and reconstruction. This topic can be difficult, because of this variety, because of the relative infrequency of the tumors, and because the considerations vary according to the underlying disease. Primary lung cancer is most common; for the most part the staging and treatment is not affected by the presence or absence of chest wall involvement (Pancoast tumors involve special consideration). An important aspect is that if there is a question of chest wall involvement it is better to err on the side of en bloc resection; a discontinuous resection is associated with worse survival. Among primary chest wall tumors chondrosarcoma is most common. With a classic presentation the clinical diagnosis is quite reliable; this is good because a limited biopsy may be misleading. Data supports primary resection with at least a 4 cm margin. For other tumors a biopsy is often helpful, because some are managed primarily with chemotherapy alone, others by resection either with or without other modalities. Knowing when a reconstruction of the chest wall is and is not necessary is also important. Many different techniques for reconstruction are available, and choosing the right one requires experience.



# **PANCOAST TUMOURS**

**Professor P. Darteville – Marie Lamelongue Hospital, Paris.**

## **INTRODUCTION:**

Henry K. Pancoast described a patient afflicted with a lung carcinoma occupying the extreme apex of the chest associated with shoulder and arm pain, atrophy of the hand muscles, and Horner's syndrome (1). This clinical entity has become known as Pancoast's syndrome. Anatomically, the pulmonary sulcus refers to the uppermost extent of the costovertebral gutter from the first rib to the diaphragm. It is understood that non-small cell lung carcinomas of this region are termed Pancoast tumors.

## **PRESENTATION:**

Pancoast tumors account for less than 5% of all bronchial carcinomas (2). These tumors may arise from either upper lobe and tend to invade parietal pleura, endothoracic fascia, subclavian vessels, brachial plexus, vertebral bodies, or first rib. Because of the peripheral location of these lesions, pulmonary symptoms are uncommon in the initial stages of the disease.

## **PREOPERATIVE STUDIES:**

Any patient presenting with Pancoast's syndrome should undergo a detailed preoperative evaluation to establish the diagnosis of bronchial carcinoma, assessing for operability. The diagnosis is established by history and physical examination, biochemical profile, chest radiographs, bronchoscopy with sputum cytology, fine-needle transthoracic biopsy, computed tomography of the chest and positron emission tomography. If there is evidence of mediastinal adenopathy mediastinoscopy is mandatory since patients with clinical N2 disease are not operative candidates.

Neurologic examination, magnetic resonance imaging or electromyography may delineate the tumor's extension to the brachial plexus, phrenic nerve, or epidural space.

Vascular invasion is evaluated by venous angiography, subclavian arteriography, Doppler ultrasonography

Additional magnetic resonance imaging is mandatory if the work-up suggests tumor encroachment into the intervertebral foramina to rule out invasion of the extradural space

## **TREATMENT:**

We know now that en bloc resection of the tumor combined sometimes with neo or adjuvant therapies must be considered the standard therapeutic approach for superior sulcus tumors. The goal of resection is the complete removal of the upper lobe in continuity with the invaded ribs, transverse processes, subclavian vessels, T1 nerve root, upper dorsal sympathetic chain, and prevertebral muscles.

In general, superior sulcus lesions not invading the thoracic inlet are completely resectable through the classic posterior approach of Shaw and colleagues (3), however, the posterior approach does not allow direct, safe visualization, manipulation, nor complete oncologic clearance of all anatomic structures of the thoracic inlet.

Superior sulcus lesions extending to the thoracic inlet should be resected by an anterior transcervical approach (4) that has been increasingly accepted as a standard approach for all benign and malignant lesions of the thoracic inlet

## **ANTERIOR TRANSCERVICAL TECHNIQUE (see figure below):**

The patient is supine with the neck hyperextended and the head turned away from the involved side. An L-shaped cervicotomy incision is made, including a vertical pre-sternocleidomastoid incision carried horizontally below the clavicle up to the deltopectoral groove. A myocutaneous flap of cleidomastoid muscle along with the upper digitations of the ipsilateral pectoralis major muscle is then folded back, providing full exposure of the cervicothoracic junction.



Tumor extension to the thoracic inlet is carefully assessed next. We recommend resection of the medial half of the clavicle only if the tumor is deemed resectable. If the subclavian vein is involved, it can be easily resected after proximal and distal control has been achieved. Direct extension of the tumor to the innominate vein does not preclude resection.

Next, the anterior scalene muscle is divided with cautery. The phrenic nerve should be preserved whenever possible.

The subclavian artery is dissected. The vertebral artery is resected only if invaded. If there is invasion of the arterial wall, resection is necessary to obtain tumor-free margins. After proximal and distal control is obtained, the artery is divided on either side of the tumor. Revascularization is performed using either polytetrafluoroethylene graft (6 or 8 mm) or, more often, an end-to-end primary

The middle scalene muscle is divided above its insertion on the first rib or higher. The nerve roots of C8 and T1 are easily identified and dissected free from outside to inside, up to where they join to form the lower trunk of the brachial plexus. Although tumor involvement of the brachial plexus may be high, neurolysis is usually achieved without division of the nerve roots above T1

The chest wall resection is completed before the upper lobectomy. The divided ribs are disarticulated from the transverse processes of the first two or three thoracic vertebrae. An upper lobectomy can be accomplished through this cavity.

We (5) developed a technique for resecting superior sulcus tumors extending into the intervertebral foramen without intraspinal extension. The underlying principle is the use of a combined anterior transcervical and posterior midline approach, allowing resection of the intervertebral foramen and division of the nerve roots inside the spinal canal. The specimen is resected en bloc with the lung, ribs, and vessels through the posterior incision

#### **SURGICAL MORBIDITY AND MORTALITY:**

Surgical complications are numerous and vary in severity.

Horner's syndrome occurs after injury to the stellate ganglion, various nerve deficits can occur as well; division of the T1 nerve root does not induce significant muscular palsy in the nerve distribution, resection of the lower trunk of the brachial plexus may result in atrophic paralysis of the forearm and small muscles of the hand.

Hemothorax may result from extensive pleural adhesions

Chylothorax should be prevented intraoperatively by extensive ligation of the cervical and intra-thoracic lymphatic vessels after meticulous dissection.

Patients having a combined transcervical and midline approach are more likely than others to develop postoperative atelectasis and perfusion-ventilation mismatch.

#### **RESULTS AND PROGNOSIS:**

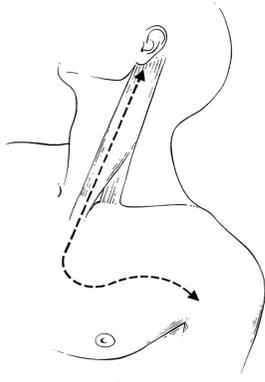
Recently, we (6) reviewed our current experience with superior sulcus tumors in 126 patients.

Complete resection was achieved in 90% of cases, resulting in a median survival time of 28 months and a 5-year survival of 39.3%. There was 1 death during the study period. By multivariate analysis, incomplete resection and subclavian artery involvement adversely affected survival ( $p = 0.01$ , each).

Overall, our results suggest that radical surgery for superior sulcus tumors may be performed in experienced centers with low mortality and favorable survival rates.



**FIGURE:**



*A left L-shaped incision cervicotomy is made and includes a vertical presternocleidmastoid incision prolonged horizontally below the clavicle up to the delto-pectoral groove*

**REFERENCES:**

1. Pancoast HK: Superior pulmonary sulcus tumor. JAMA 99:1391, 1932.
2. Ginsberg RJ, et al: Influence of surgical resection and brachytherapy in the management of superior sulcus tumor. Ann Thorac Surg 57:1440, 1994.
- 3 Shaw RR, Paulson DL, Kee JLJ: Treatment of the superior sulcus tumor by irradiation followed by resection. Ann Surg 154:29, 1961.
4. Darteville PG, et al: Anterior transcervical-thoracic approach for radical resection of lung tumors invading the thoracic inlet. J Thorac Cardiovasc Surg 105:1025, 1993.
5. Darteville PG: Extended operations for lung cancer. Ann Thorac Surg 63:12, 1997.
6. Yildizeli B, et al.: Results of primary surgery with T4 non-small cell lung cancer over a 25 year period in a single center: the benefit is worth the risk. Ann Thorac Surg. 86(4):1065-75, 2008 ; discussion 1074-5.



# TRACHEAL SURGERY

**Professor D. Wood – University of Washington, U.S.A.**

Benign and malignant central airway obstruction produces progressive symptoms of dyspnea, stridor, and obstructive pneumonia. The nature and degree of symptoms are dependent upon the location and magnitude of the obstructing lesion. Tumors involving the trachea or carina may have minimal symptoms until the airway becomes critically narrowed, but then are life threatening due to impending suffocation.

Bronchoscopic management is the first step in evaluating the patient with suspected airway stenosis. Bronchoscopy allows confirmation of the diagnosis, stabilization of the obstructed airway, and evaluation for potential resectability. In patients that are unresectable, therapeutic bronchoscopy is minimally invasive and may provide significant palliation. Prompt intervention can be life saving for patients with tracheal obstruction, provides immediate palliation for patients with symptomatic airway obstruction, and may simplify other management such as chemotherapy or radiation.

The most common etiology of benign airway stenosis is post-intubation, related to a cuff injury or excessive contracture of a tracheostomy stoma. The other common etiologies are trauma and inflammatory, both infectious and related to other systemic disease. Most of these patients can be temporarily palliated with endoscopic tracheal dilatation, but will ultimately require tracheal resection and reconstruction for long-term definitive management.

The optimal management for a patient with malignant airway obstruction is dependent upon the natural history of the tumor and the anatomic location of involved airway. Treatment is also dependent upon patient co-morbidities, pulmonary function, previous treatments, and life expectancy of the patient. Unfortunately, treatment decisions are often heavily determined by the experience, or lack thereof, in the management strategies available for patients with central airway disease. Tumors involving the airway are relatively uncommon and, except for a handful of thoracic surgeons and pulmonologists, most individuals will see only an occasional patient with obstructing tracheobronchial pathology. However, the best opportunity for successful treatment depends on a thoughtful consideration of the variety of therapies available, applying them in a systematic algorithm to achieve the optimal results in each individual patient.

Most patients with primary tracheobronchial tumors and selected patients with adjacent primary tumors affecting the airway may be amenable to surgical resection and reconstruction. Since primary tumors nearly always involve the full thickness of the airway, primary resection and reconstruction should always be considered as the definitive surgical treatment.

The principles of tracheobronchial surgery can be applied to essentially all benign and malignant airway pathology. In general, resection should be the procedure of choice if it appears that the pathology can be completely resected while still allowing primary airway reconstruction. Reconstruction depends largely on the longitudinal extent of resection since there are no prosthetic tracheal substitutes. For lesions involving the cervical and intrathoracic trachea, up to half of the trachea can be excised and primarily reconstructed. For resections that involve the carina, longitudinal involvement of more than 4 cm of the airway precludes primary airway reconstruction in the vast majority of cases. Cardiopulmonary bypass is rarely necessary for these resections of the trachea or carina and jet ventilation is potentially dangerous if performed distal to airway obstruction. Patients with tumors involving the proximal half of the trachea can usually be resected through a low collar incision while lesions of the distal third of the trachea and carina can be resected through a right thoracotomy. Dissection of the airway is limited to the region to be resected in order to preserve tracheobronchial blood supply. A variety of release maneuvers are critical for allowing complete resection and a reconstruction without tension. The principles of anastomotic technique are critical to successful airway resection and reconstruction for tracheobronchial malignancy. Precise placement of interrupted absorbable sutures allows an airtight anastomosis, correction of size discrepancy between the distal and proximal airway, and minimal anastomotic granulations if the anastomosis is brought together without tension.

Tracheal surgery is demanding and requires perfect outcomes since secondary procedures are much less effective. The most important aspects are exquisite judgment regarding indications and risks of surgery, meticulous surgical technique, and the complete battery of complementary therapeutic endoscopic skills to prepare patients for surgery and manage postoperative complications.



## References

1. Wood DE. Tracheal Tumors. In: Wood DE, Thomas CR Jr., Eds. *Mediastinal Tumors*, Berlin, Germany: Springer-Verlag, 1995:87-94.
2. Wood DE. Tracheal and bronchial stenting. In Grillo HC, (ed) *Surgical Management of the Trachea*. Hamilton, Ontario, BC Becker, in press.
3. Wood DE. Bronchoscopic preparation for airway resection. *Chest Surg Clin NA* 2001;11:735-48.
4. Mathisen DJ, Grillo HC. Carinal resection for bronchogenic carcinoma. *J Thorac Cardiovasc Surg* 1991;102:16-23.
5. Wilson RS. Anesthetic management for tracheal reconstruction. In: Grillo HC, Eschepasse H, (eds), *International Trends in General Thoracic Surgery: Volume 2: Major Challenges*, WB Saunders, Philadelphia, 1987, pp 3-12.
6. Wood DE, Vallières E, Karmy-Jones K. Tracheobronchial resection and reconstruction. *Seminars Resp Crit Care Med* 1999;20:463-72.
7. Heitmiller, RF. Tracheal release maneuvers. *Chest Surg Clin NA* 1996;6:675-82.
8. Grillo HC. Tracheal surgery. In Ravitch M, Steichen F (eds): *Atlas of General Thoracic Surgery*. Philadelphia, WB Saunders, 1987, pp 293-331.
9. Wood DE. Management of malignant tracheobronchial obstruction. *Surg Clin NA* 2002; 82:621-42.



# **EMPHYSEMA – PAST, PRESENT AND FUTURE**

**Professor D. Wood – University of Washington, U.S.A.**

## **Introduction**

The modern era of lung volume reduction surgery (LVRS) was first described by Dr. Joel Cooper and his colleagues at Washington University in 1994. Using a median sternotomy to perform bilateral stapled wedge resections on patients with heterogeneous emphysema and plethysmographic evidence of hyperinflation resulted in an objective improvement in forced expiratory volume in one second (FEV<sub>1</sub>) of 82%. These exciting results led to a rapid dissemination of LVRS throughout the United States in both academic and community centers. It is estimated that 1,212 LVRS procedures were performed between July, 1994 and December 1995. In the initial 7 publications on lung volume reduction surgery totaling 738 patients, the improvement in FEV<sub>1</sub> averaged 61% and the six minute walk increased by 46%. This was accompanied by an improvement in dyspnea scale and quality of life at the cost of 2.5% - 10% operative mortality and an 11-17 day hospitalization. Although these results were encouraging, there were a number of criticisms of the published reports relating to small patient numbers, variable selection criteria, lack of patient randomization, incomplete follow-up, and lack of long term results.

## **The National Emphysema Treatment Trial**

In 1995, the Health Care Finance Administration (HCFA), now known as the Center for Medicare and Medicaid Services (CMS) discontinued reimbursement for LVRS procedures. Because of an immediate and vociferous outcry from patients and their physicians, Medicare bowed to public and legislative pressure and agreed to fund the historic National Emphysema Treatment Trial (NETT) as a pioneering collaboration between the National Institutes of Health (NIH) and Medicare (CMS) in evaluating a new surgical procedure. The NETT developed as a multi-institutional prospective randomized clinical trial comparing medical therapy to LVRS in patients with severe emphysema. Seventeen clinical centers throughout the United States and a Data Coordinating Center were involved in the trial.

The primary outcome measures in the NETT were survival and maximum exercise capacity two years after randomization. Secondary outcome measures were quality of life, disease-specific symptoms, cost effectiveness, pulmonary function, gas exchange, oxygen utilization, radiologic assessment and psychomotor function.

In May, 2003 the primary outcomes of the 5-year National Emphysema Treatment Trial were presented. Overall, 1,218 patients were randomized to undergo lung volume reduction surgery or continued medical therapy (608 assigned to LVRS) and the overall mortality of 0.11 death per person year was identical in both treatment groups. A 10 watt or greater improvement was seen in 16% of surgical patients compared with 3% of medical patients ( $p < 0.001$ ). In secondary outcome measures of FEV<sub>1</sub> and HRQOL as measured by the quality of well-being score (QWB), surgically treated patients showed significant improvement over medical patients at 6, 12, and 24 months.

One of the critical components of the NETT was to try to identify baseline characteristics and identify differential likelihood of benefit for patients considering LVRS. Although a large number of characteristics were examined, only upper lobe predominance of emphysema and baseline exercise capacity was associated with differences in predicting primary outcomes. These two characteristics allowed the NETT patients to be divided into four subgroups on the basis of combinations of upper lobe or non-upper lobe emphysema and low or high exercise capacity at baseline. Of the 1,078 patients, 290 had upper lobe disease and low exercise capacity, and these patients not only showed a favorable impact of surgery on exercise capacity and quality of life, but also showed an improvement in survival in the surgically treated patients. Four hundred nineteen patients had upper lobe disease and high exercise capacity. Mortality was similar in the two treatments groups, but surgically treated patients had a significant improvement in both exercise capacity and health related quality of life at 24 months. The 149 patients with non-upper lobe disease and low exercise capacity had a similar risk of death regardless of the treatment group and did not show a significant difference in the maximum exercise capacity. However surgically treated patients did show an improvement in health related



quality of life. Finally, the 220 patients with non-upper lobe disease and exercise capacity had both a higher risk of death and no significant benefit of surgery in improving exercise capacity or quality of life.

Concomitant with the NETT, several investigators have evaluated additional techniques for palliating emphysema with endobronchial valves, creation of intrabronchial fistulae, and ablation/consolidation of areas of upper lobe emphysema. Several of these are engaged in, or recently finished as clinical trials and offer possible alternative and less invasive therapies for patient with emphysema. In the U.S., successful completion of the NETT trial has been followed by a disappointing lack of referrals of patients for LVRS, most likely representing a misunderstanding of LVRS outcomes by pulmonary physicians and patients. Education is necessary to assure access of patients to treatment that shows clear improvements in exercise capacity, quality of life, and in some patients, survival.

## References

1. National Emphysema Treatment Trial Research Group. The National Emphysema Treatment Trial: A comparison of median sternotomy versus VATS for lung volume reduction surgery. *J Thorac Cardiovasc Surg*. In press.
2. National Emphysema Treatment Trial Research Group. A randomized trial comparing lung volume reduction surgery with medical therapy for severe emphysema. *N Engl J Med* 348:2059-73, 2003.
3. National Emphysema Treatment Trial Research Group. Patients at high risk of death after lung-volume-reduction surgery. *N Engl J Med*, 345:1075-83, 2001.
4. National Emphysema Treatment Trial Research Group. Cost effectiveness of lung-volume-reduction surgery for patients with severe emphysema. *New Engl J Med* 348:2092-2102, 2003.
5. Naunheim KS, Wood DE, Krasna MJ, DeCamp MM Jr, Ginsburg ME, McKenna RJ Jr, Criner GJ, Hoffman EA, Sternberg AL, Deschamps C, National Emphysema Treatment Trial Research Group. Predictors of operative mortality and cardiopulmonary morbidity in the National Emphysema Treatment Trial. *J Thorac Cardiovasc Surg*. 2006 Jan;131(1):43-53.
6. Ramsey SD, Shroyer AL, Sullivan SD, Wood DE. Updated evaluation of the cost-effectiveness of lung volume reduction surgery. *Chest* 2007; 131:823-832.
7. Naunheim KS, Wood DE, Mosenifar Z, Sternberg AL, Criner G, DeCamp MM, Deschamps C, Martinez FJ, Sciurba FC, Tonascia J, Fishman AP. Long-term follow-up of patient receiving lung volume reduction surgery versus medical therapy for severe emphysema. *Ann Thorac Surg* 2006; 82:431-43.
8. Wood DE, McKenna RJ, Yusef RD, Sterman DH, Ost DE, Springmeyer SC, Gonzalez HX, Mulligan MS, Gildea T, Houck W, Machuzak M, Mehta AC. A multi-center trial of an intrabronchial valve for treatment of severe emphysema. *J Thorac Cardiovasc Surg* 2007; 133:65-73.
9. Ingenito EP, Wood DE, Utz JP. Bronchoscopic lung volume reduction in severe emphysema. *Proc Am Thorac Soc* 2008; 5:454-60.
10. Wood DE. Results of lung volume reduction surgery for emphysema. *Chest Surg Clin NA* 2003; 13:709-26.

