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Benign tumours of the bronchus and trachea, 1951–1981

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Summary

A review has been made of 128 benign tumours of the bronchus seen at a Regional Thoracic Surgery Centre during the 30-year period, 1951–1981. These have included 74 cases of carcinoid tumour of the bronchus and 38 cases of hamartoma. The similarity of the histological appearances of carcinoid to oat cell carcinoma is stressed, together with its clinical implications. A 5–30-year follow-up of the cases of bronchial carcinoid shows that it is essentially a benign tumour, though late recurrence may occur. The use of the somewhat forgotten technique of a Gebauer skin graft in bronchoplastic surgery is described.

Introduction

"Le Combat contre les Ombres"

This lecture reports a series of innocent tumours of the bronchus and trachea seen at a Regional Thoracic Surgical Centre from 1951 to 1981. The majority have been carcinoid tumours of the bronchus and so-called chondromatous hamartomas. The angiomatous type of hamartoma, in which there is a congenital arteriovenous communication in the substance of the lung, has not been included as it is not a true tumour, but it is interesting to recall that in 1762 William Hunter, John's elder brother, reported for the first time *(1)* 2 cases of traumatic arteriovenous communication following injury to the brachial artery after the operation of blood-letting, a procedure frequently practised in the 18th century.

In the Hunterian Museum there is only one specimen (Fig. 1) of a lung tumour, consisting of several rounded lobulated masses and described in Hunter's own words as a "firm, white, cancerous substance". At the end of the last century this was considered to show the histological features of a chondro-sarcoma. How interesting and fascinating it would be to obtain a modern interpretation of the histological appearance of this tumour!

Classification

Benign tumours of the bronchus and trachea are classified according to their cell of origin. They may be derived from:
Cells of neural origin of which bronchial carcinoid is the commonest; benign clear cell tumour, neurofibroma and myoblastoma are all very rare.
Bronchial epithelium—papilloma.
Pulmonary and bronchial mesenchyme—chondroma, lipoma, leiomyoma and fibroma.
Bronchial epithelium and mesenchyme—hamartoma. The commonest tumours are bronchial carcinoid, hamartoma and chondroma.

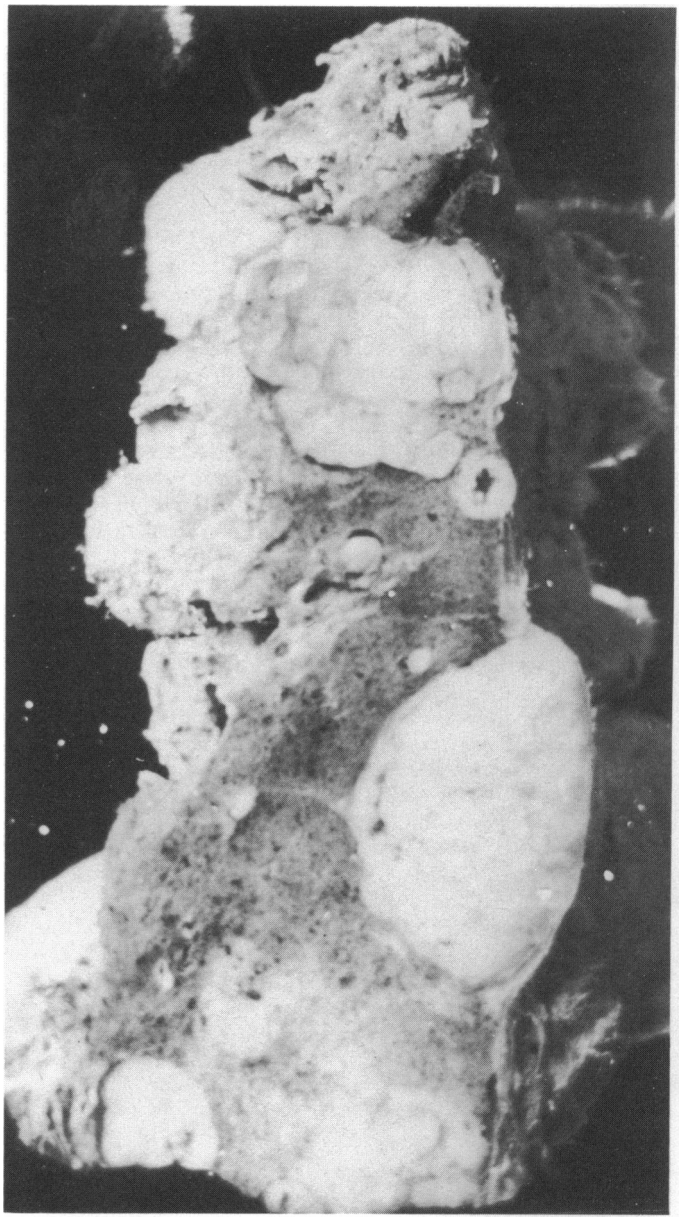

FIG. 1 Specimen from Hunterian Museum—considered at end of last century to be a chondrosarcoma. How interesting and fascinating it would be to obtain a modern interpretation of the histological appearances of this tumour!

Based on a Hunterian Lecture delivered at the Royal College of Surgeons of England on 18th March 1981.

The term *adenoma of the bronchus* must be mentioned, for this name has caused considerable confusion in the literature during the past 20 years. An adenoma is derived from the duct epithelium of a bronchial mucous gland but it is only recently that it has been accepted that although 90% of these tumours are bronchial carcinoids the term also includes three tumours of salivary gland type—the malignant adenoid cystic carcinoma (cylindroma) and muco-epidermoid carcinoma, together with the extremely rare innocent mucous gland cystadenoma. The term *adenoma of the bronchus*, which implies a completely benign tumour, should no longer be used as it includes tumours of such different malignant potential.

The 128 cases were classified as follows:

Carcinoid	74
Hamartoma	38
Chondroma	7
Endobronchial lipoma	3
Leiomyoma	2
Papilloma	1
Polyp	1
Adenoid cystic carcinoma (cylindroma)	2

An adenoid cystic carcinoma (cylindroma) is not benign but has been included in this series as it used to be grouped under the general heading of bronchial adenoma.

Innocent tumours are reported to comprise 1% of all lung tumours and 5–10% of all surgically excised lung tumours. During the same period 3500 lung resections have been carried out for bronchial carcinoma, giving an incidence of 4% for benign tumours during this 30-year period.

Carcinoid tumours

Carcinoid tumours of the lung were first described by Mueller just over 100 years ago *(2)*. There is still much controversy concerning their true nature and their degree of malignancy ranging from the experience of the Memorial Cancer Centre in New York *(3)* that they are rapidly growing tumours with a discouraging 5-year survival rate to the Mayo Clinic experience *(4)* of a relatively benign tumour with an 87% 10-year survival rate. There is so much difference of opinion in the literature concerning the malignancy of this tumour that one sometimes wonders whether the same tumour is being discussed. This can only be due to a difference in interpretation and classification of the histological appearances. A true carcinoid tumour may be associated with long survival, even in the absence of effective treatment *(5,6)*.

Seventy-four cases are included in this series and will be reported more fully elsewhere *(7)*. There were 35 men and 39 women, and the mean age was 49 years. Six cases were under the age of 19 years, the youngest two both being 14 years of age. Two cases were over 70, aged 71 and 75 years. In most cases the tumour projected into the lumen of the bronchus as a well-defined lobulated mass with a broad base or a narrow pedicle and this eventually led to bronchial obstruction and collapse of a lobe or lung. Presenting symptoms were recurrent bouts of respiratory infection in half the cases and haemoptysis in one-third of cases. In one-fifth of cases there were no symptoms and the tumour was discovered on a routine chest radiograph. None of the cases presented with the carcinoid syndrome of diarrhoea and flushing of the face which sometimes occurs with an intestinal carcinoid. All cases had an abnormal chest radiograph.

In the majority of cases the tumour was visible at bronchoscopy and the diagnosis confirmed on biopsy. It has been repeatedly stated in the literature, though with little statistical support, that biopsy in suspected carcinoid is contraindicated because of the risk of haemorrhage. In this series in which the biopsy has always been carried out at *rigid* bronchoscopy, haemorrhage has not caused any real problem.

RESEMBLANCE TO OAT CELL CARCINOMA

In 3 cases the tumour was reported as oat cell carcinoma—1, 20 years ago before the present refinements of histological diagnosis and 2 more recently on the small biopsy obtained at fibreoptic bronchoscopy. In these last 2 cases the true innocent nature of the tumour was only appreciated at subsequent rigid bronchoscopy in 1 and subsequent pneumonectomy in the other. It is extremely important to appreciate the possibility of this incorrect diagnosis in view of the increasing use of fibreoptic bronchoscopy and the increasing tendency, incorrect in the author's view, to treat all oat cell carcinoma by radiotherapy alone.

TREATMENT

The treatment of these tumours has been essentially conservative resection in the belief that they are not frankly malignant. The type of operation has depended upon the site of the tumour and the condition of the lung distal to the blockage—in 59 cases resection of lung by lobectomy or pneumonectomy was required due to bronchiectasis or chronic infective changes distal to the tumour.

Operations performed were as follows:

Pneumonectomy	10
Lobectomy	46
Local resection of bronchial wall and tumour, with preservation of lung (closure of bronchus with Gebauer skin graft in 3 cases)	6
Upper lobectomy by 'sleeve' resection of main bronchus (2 cases) or middle lobectomy and closure of bronchus by Gebauer skin graft (1 case)	3
Segmentectomy	6
Enucleation	2
Wedge resection	1

Many of these cases of carcinoid were found at operation to have lymph node enlargement, but this was generally due to infection in the lung distal to the tumour, and in only 1 of these 74 cases was there actual gland involvement by tumour. This case was treated in 1951 and has unfortunately been lost to follow-up. Gland involvement naturally implies that a more radical resection should be undertaken and now that frozen section is so much more easily available in the operating theatre, this should be assessed histologically at operation and not in retrospect in the laboratory.

There was no case of atypical carcinoid.

FOLLOW-UP

The follow-up of these cases shows that the prognosis is good, even though a conservative resection policy has been adopted. A 5–30-year follow-up has been obtained in 48 cases. Seven of the early cases have been lost to follow-up but the remainder have all been traced. Some of the early cases have died from unrelated causes and these have been excluded from the survival rates.

Actuarily assessed survival by a life table analysis *(8)* shows an 80% 15-year survival, decreasing to 64% at 25 years (Fig. 2).

Of the 9 cases treated by conservative *bronchial* resection with conservation of lung tissue, ie by bronchotomy with or without lobectomy and with or without closure of the bronchus by a graft, there has been no recurrence of the tumour in the 8 cases treated over 5 years ago or 4 cases treated over 10 years ago.

The occasional late development of secondary deposits of bronchial carcinoid in the liver and elsewhere is well documented in the literature and may occur up to 20 years after the primary growth has been resected *(9)*. Two of these cases have recurred—the mode, site and subsequent clinical state of these 2 patients is interesting and unexpected.

One patient had a left lower lobectomy at the age of 16 years, a completion pneumonectomy due to a local recurrence at 24 years and then 9 years later at 33 years of age

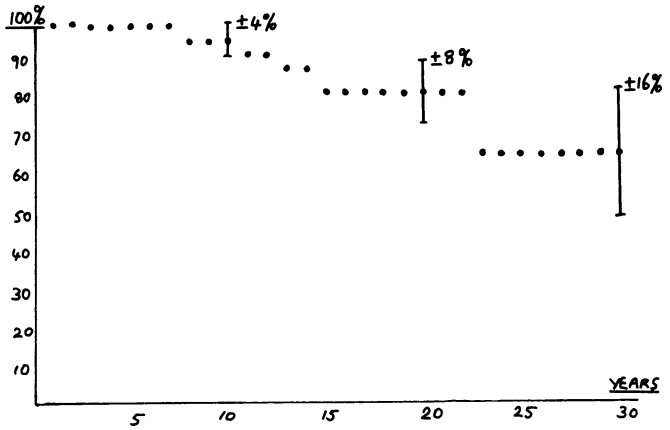

FIG. 2 Actuarily assessed survival by a life table analysis of 48 patients.

developed liver metastases. He remains well and at work 4 years after selective embolisation of the liver.

The second patient had a right lower lobectomy at the age of 26 years. Sixteen years later at the age of 42 years he developed multiple metastases in the liver, spleen and retroperitoneal space, together with multiple minute polypoid carcinoid lesions at the origin of the *left* main bronchus, possibly secondary deposits but more likely to be new primary growths. He also continues to remain well and at work 2 years later, despite these extensive abdominal secondary deposits which were considered to be too extensive to treat.

The histology of both these cases has been reviewed and in both cases was typical carcinoid, not the atypical variety. In neither case was there glandular involvement at operation.

THE EXTENT OF RESECTION FOR BRONCHIAL CARCINOID

There has been considerable discussion in the past concerning the extent of resection for bronchial carcinoid. Earlier reports stressed the innocent nature of these tumours but some more recent articles have emphasised their malignant potential and have advised against conservative surgery, all cases to be treated by lobectomy or pneumonectomy *(10,11)*. One of the reasons for these conflicting views is that in many reports in the literature, carcinoid has not been separated from the much less common adenoid cystic carcinoma (cylindroma), a tumour which is very much more malignant. If involved lymph nodes are present at operation, then it is prudent to carry out a more radical resection. But the involvement of lymph nodes by tumour must be confirmed by frozen section at the time of operation.

Our experience is that a carcinoid tumour of the lung should be considered to be a tumour of only slight malignant potential which may be treated by conservative resection of the tumour by bronchotomy or sleeve resection of the bronchus if possible. However, lung resection is required in over two-thirds of cases because of infective lung changes distal to the tumour or because of extension of the tumour into the lung parenchyma. These are also the recent views reported from the Mayo Clinic and by Pearson from Toronto *(4,12,13)*. It is likely that the potential malignancy of carcinoid has been overstated by some authors in the past.

Gebauer skin graft

The use of a skin graft for bronchial closure was first described by Gebauer from Honolulu in 1950 for the treatment of tuberculous strictures of the trachea and main bronchi *(14–16)*. With the advent of anti-tuberculous chemotherapy these problems do not now occur and the use of skin grafts has virtually ceased and the technique is almost forgotten. The procedure does, however, still have a place in bronchoplastic surgery and has been used in 4 cases of carcinoid, 1 case of leiomyoma and also, combined with a lobectomy, in 18 cases of well-differentiated squamous carcinoma.

The graft is full thickness skin and is taken from the edge of the thoracotomy wound. Fatty tissue is removed from the posterior surface and the graft is cut to a size slightly larger than the defect in the bronchus to be closed. This is important as otherwise a stenosis will occur later. The graft is strengthened by a lattice work of No 2 SWG stainless-steel wire through its thickness (Fig. 3) and then sutured in place with interrupted mersilene sutures, with the epidermis inside (Figs 4, 5). These grafts regain a blood supply and remain as viable tissue. The adjacent bronchial epithelium grows over the inner surface of the graft and the hair follicles gradually disappear.

In these 23 cases the graft has been used as a gusset rather than as a tube and there has been no case of late stricture formation or other complication related to the use of the graft.

Figure 6 shows the position of the graft in the 4 carcinoid cases.

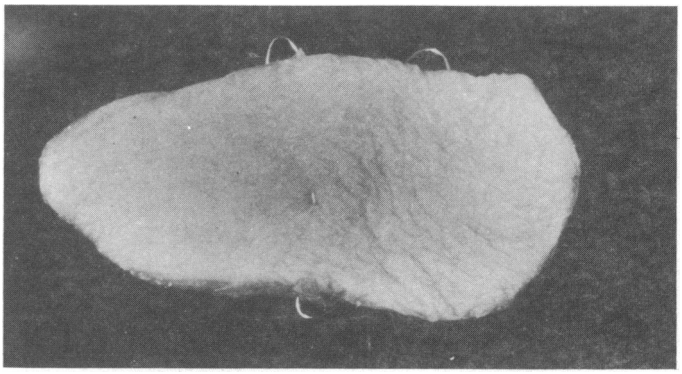

FIG. 3 Gebauer skin graft. The graft is strengthened by No 2 SWG stainless-steel wire threaded through its thickness in a criss-cross manner, intentionally made to appear more obvious in this illustration.

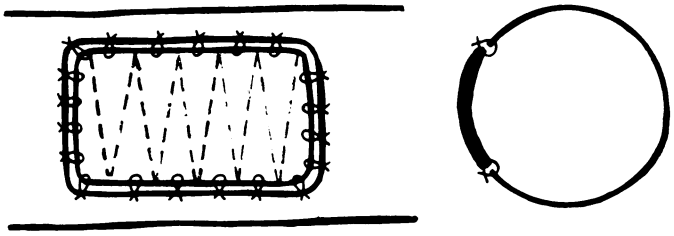

FIG. 4 Insertion of graft in bronchial wall to prevent a bronchostenosis.

Chondromatous hamartoma

There were 38 cases of chondromatous hamartoma, of which 2 were endobronchial. All except 3 cases occurred as a peripheral symptomless shadow picked up on a routine chest radiograph, a so-called 'coin' lesion, which in reality is spherical in shape and not flat. The shadow was well defined and sometimes slightly lobulated, with scattered punctate calcification in 1 case. The sex incidence was virtually equal and the average age of the patients was 54.5 years, with most of the tumours occurring in the 50–70 year age group. The hamartoma occurred twice as frequently in the lower lobe as the upper lobe.

A hamartoma is usually just under the lung surface, feels hard and is often lobulated. A characteristic feature is that it is mobile in the lung substance, best described as 'moving like a piece of soap'. These features resemble those of a fibroadenoma of the breast, which, because of its mobility, is sometimes called a 'breast mouse'; a hamartoma could equally well be called a 'lung mouse'. An incision through the overlying lung will enable the tumour to be easily enucleated and all except 3 early cases and the 2 endobronchial tumours were treated in this way.

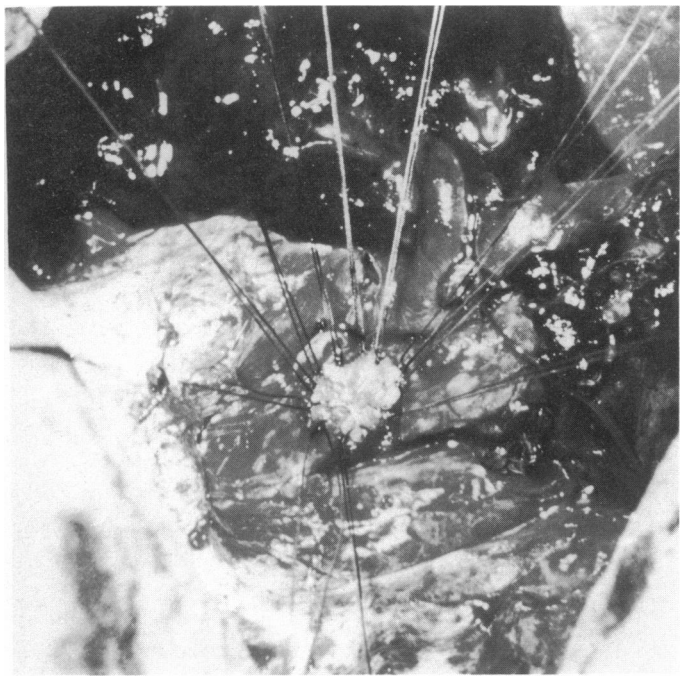

FIG. 5 Graft in position on lateral wall of right main bronchus.

FIG. 6 Position of the graft in the 4 carcinoid cases.

PATHOLOGICAL FEATURES

The name hamartoma, first introduced by Albrecht in 1904, is derived from the Greek words for 'error' and 'tumour' *(17)*. It was originally applied to a developmental tumour-like malformation in which the normal components of an organ were abnormally represented. Unfortunately the term has now come to be widely used for a great variety of conditions in many organs and because of misuse it has lost much of its original meaning. A pulmonary hamartoma may be vascular or chondromatous. The chondromatous variety cannot be a developmental abnormality for it is extremely rare under the age of 20 and occurs predominantly over the age of 50 years. In addition there are many reports in the literature of radiological increase in size of the lesion, all in patients over the age of 50 years.

This age incidence alone makes it most unlikely that it is a true congenital abnormality as also does its increase in size in middle age. Albrecht appreciated these facts and coined the less well-known and rather clumsy word hamartoblastoma for this lesion. Willis *(18)* considered the condition to be a mixed tumour of the bronchial wall, in which there is epithelial and mesenchymal tissue. This correlates well with its clinical behaviour. The term 'hamartoma' should only be used for lesions showing clear evidence of an underlying developmental abnormality, either present at birth or manifested by excessive growth during normal tissue maturation. But, as Le Roux *(19)* has said so well 'the term hamartoma, whilst convenient and attractive, is easily abused and the evidence is more often philosophical than scientific. The term chondromatous hamartoma is so deeply ingrained in the literature that it will continue to be used by the present generation of thoracic surgeons and respiratory physicians and none of the alternative names is completely satisfactory.'

On histological examination all the elements of a normal bronchus are seen with cartilage, muscle and epithelial tissue, together with ciliated epithelium lining clefts in the tumour. There may also be cystic spaces and the cartilaginous portion may show calcification. Some hamartomata may not contain all of these elements, and may consist mainly of undifferentiated mesenchyme and contain the minimum of cartilage or even none at all. All except 4 cases were of characteristic histology. The mode of growth of a hamartoma is papillary or polypoid and there is proliferation of bronchial epithelium, accompanied by proliferation of underlying mesenchymal tissues. This tumour is exactly comparable to a fibro-adenoma of the breast, which incidentally Albrecht also included within the term 'hamartoma'. None of the cases showed any evidence of malignant change. A follow-up of most of these 38 cases has not revealed the development of a further lesion.

Chondroma

There were 7 cases of chondroma which consist almost entirely of mature cartilage, in contradistinction to a cartilaginous hamartoma which will also include epithelial elements. These tumours are not associated with disordered growth of the *other* constituents of the bronchial wall. They all occurred over the age of 50 years and all felt very hard at operation, much more so than a hamartoma. Two were enucleated and the diagnosis confirmed by frozen section. Two were indistinguishable from carcinoma, and a lobectomy or pneumonectomy was performed. Two cases occurred as pedunculated tumours in the trachea about 3 cm above the carina. Indeed these were the only truly innocent tracheal tumours in the series. Both were excised through a right thoracotomy and the tracheal deficit closed by direct suture.

Endobronchial lipoma

Surprisingly there were 3 cases of endobronchial lipoma which also contained an appreciable quantity of fibrous tissue. They grew into the bronchial lumen, obstructed the bronchus and caused infective symptoms. At bronchoscopy

the tumour appeared as a yellow-grey pedunculated mass covered by intact epithelium. Biopsy confirmed the diagnosis in 2 cases.

Leiomyoma

A leiomyoma, which develops from the smooth muscle of the tracheobronchial tree, is a rare tumour and may occur in the lung substance or as a pedunculated tumour in a bronchus. One example of each was seen. Both were in women who presented with haemoptysis, and in both cases it was thought wise to exclude a primary uterine growth.

In 1 case a middle lobectomy was carried out and in the other the tumour was excised and the deficit in the bronchial wall closed with a Gebauer skin graft.

Papilloma and polyps

There was 1 case each of papilloma and polyp, two unusual conditions which resemble each other on macroscopic appearance but are of very different aetiology and may often, as in these 2 cases, be removed entirely by bronchoscopic avulsion.

The papilloma occurred in a lady aged 65 years. It was in the main bronchus and had caused complete collapse of the lung. When the biopsy was taken the whole tumour came away and the bronchial lumen looked normal. The histology showed it to be a simple papilloma, with a connective tissue core covered in squamous and ciliated epithelium. The lung re-expanded and she has remained well for 15 years.

A bronchial polyp, on the other hand, is associated with chronic infection, may occur at any age and resembles very closely a nasal polyp. It is due to a break in the mucosal lining of the bronchus leading to proliferation of granulation tissue and subsequent epithelialisation. These polyps are often quite large and have a smooth surface. The case included in this series was 70 years of age and described episodes of what he called 'choking' over the previous 4 years. Bronchoscopy showed a large polyp in the right main bronchus and biopsy resulted in the whole polyp being removed. Histologically there is a fibrous tissue stroma with marked inflammatory cell infiltration and deep infolding of the mucosal lining.

Adenoid cystic carcinoma

There have been only 2 cases of adenoid cystic carcinoma, or what used to be called cylindroma. This is surprising for in a series of 74 carcinoids one would have expected to have seen 6 or 7 cases. The tumour generally occurs in the trachea.

The chest radiograph was normal in both cases, a man aged 61 years and a woman aged 63 years. The presenting symptoms were haemoptysis and stridor respectively. The tumours were both situated low in the trachea and were removed with a cylinder of trachea through a right thoracotomy.

Conclusions

(1) Carcinoid tumours of the lung have only a very slight malignant potential and should be treated by conservative bronchial resection, together with lung resection if there are distal infective changes, or extension of tumour into the lung parenchyma.

(2) The histological appearances of carcinoid and oat cell carcinoma may be similar *especially in the small biopsy obtained at fibreoptic bronchoscopy.*

(3) The use of a Gebauer skin graft is a valuable technique in bronchoplastic surgery to allow conservation of lung tissue.

(4) The follow-up of cases of bronchial carcinoid should be for at least 25 years, in view of the occasional late development of secondary deposits.

I should like to thank Professor Grunkemeier for the production of the life table and actuarily assessed survival curve. It is a pleasure to acknowledge my indebtedness to my colleague Mr Michael Bates for allowing me to include his cases in this lecture.

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