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VALUE OF BRONCHOSCOPY IN CLINICAL PRACTICE

A REVIEW OF 1,109 EXAMINATIONS

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Bronchoscopy now has an established place in the investigation of respiratory disease. Its most important application is in the field of lung cancer, in which it often provides conclusive proof of the diagnosis at a much earlier stage than would otherwise be possible. Bronchoscopy may also be of value in the investigation of pulmonary tuberculosis and bronchiectasis, in which abnormalities of the bronchi may alter the course of the disease or modify treatment.

During the past few years there has been a steadily increasing demand for the provision of facilities for bronchoscopic examination. This has been due not only to the increasing prevalence of lung cancer but also to a change in attitude among physicians, who now regard bronchoscopy as an indispensable adjunct to clinical and radiographic examination wherever there is the remotest possibility of a lung tumour being present. Although this attitude is wholly admirable it could perhaps be exploited to even better advantage if current views on the value and limitations of bronchoscopy were more widely known, and this paper is an attempt to present that information in the light of experience with over 1,000 consecutive examinations.

At the respiratory diseases units of two Scottish hospitals, bronchoscopy was carried out on 1,109 patients during the four-year period 1952 to 1956. Of these, 950 were under our direct clinical supervision, and we were able to establish a definite diagnosis in all of them. The remaining 159 patients were referred from other hospitals specifically for bronchoscopy: a diagnosis of tumour was made in 30 and they were transferred to our supervision for their investigation to be completed; the remaining 129 were returned to their own physicians for further investigation once we were satisfied that the presence of a tumour had been excluded on adequate radiographic and bronchoscopic evidence. As full details of the final diagnosis were not always available in these cases they have not been included in the analysis.

Indications for Bronchoscopy.—The 1,109 cases were submitted to bronchoscopy for one of the following reasons: (1) to establish a diagnosis in patients suspected on clinical or radiographic grounds of having a tumour; (2) to exclude the presence of a tumour or any other cause of bronchial obstruction in patients believed to have bronchiectasis; (3) to exclude the presence of a tumour or to confirm a diagnosis of endobronchial tuberculosis in patients known to have pulmonary tuberculosis; and (4) other reasons—for example, removal of foreign bodies or aspiration of obstructing secretions.

Method

Premedication.—All in-patients submitted to bronchoscopy—that is, about two-thirds of all cases—were given a barbiturate to allay apprehension and because such drugs may reduce the incidence of sensitivity reactions to local analgesia with cocaine and its analogues (Penman, 1957). One hour before the examination all patients were given a subcutaneous injection of papaveretum hydrochloride ("omnopon") and hyoscine. The dosage, which was assessed individually according to the patient's height and weight, ranged between ¼ and ½ gr. (22 and 44 mg.) of omnopon and 1/150 and 1/75 gr. (0.43 and 0.87 mg.) of hyoscine. Particular caution was observed in elderly or debilitated patients, who seem abnormally susceptible to morphine and hyoscine in standard dosage, and in those with severe emphysema or bronchial asthma in whom hypoventilation caused by the morphine may lead to anoxia and retention of carbon dioxide. All those patients normally received one-half to two-thirds of the standard dose, but in a few cases with severe emphysema omnopon was omitted altogether and only atropine was given.

Anaesthesia.—Every bronchoscopic examination was carried out under local surface analgesia. In four-fifths of the cases a 1% solution of amethocaine was used, the usual total dose being 6 to 10 ml., to which was added 0.3 to 0.5 ml. of 0.1% adrenaline. In the remainder, 4 to 8 ml. of 4% lignocaine ("xylocaine") was used in place of amethocaine. In all cases the upper limit of dosage was strictly observed.

Technique of Bronchoscopy.—A Negus bronchoscope of appropriate calibre was employed in all cases and full use was made of the direct, right-angle, and retrograde telescopes. An attempt was always made to inspect every segmental orifice normally accessible to bronchoscopic vision, and only very seldom could this not be done. In general, the right-angle telescope was of much

greater value than the retrograde telescope for inspection of the upper lobar bronchi. The same instrument also provided a useful view within the apical (lower) segmental bronchus.

Biopsy was performed in every case which showed a visible bronchial abnormality. If there was presumptive radiographic evidence of a tumour in the apical or basal segments of either lower lobe, in the right middle lobe, in the lingular segment of the left upper lobe, or in the anterior segment of the right upper lobe an attempt was made, even if there was no visible bronchial abnormality, to obtain histological confirmation of the diagnosis by so-called "blind biopsy." This was done by introducing biopsy forceps deeply into the related bronchus and cautiously removing tissue. If the forceps were felt to grip a carina they were withdrawn and reintroduced in a slightly different direction. In some of these cases a fine gum-elastic bougie was inserted into the bronchus of the segment or lobe under suspicion prior to "blind biopsy." Occasionally in the presence of a tumour obstruction of a segmental bronchus was detected in this way and bleeding sometimes followed withdrawal of the bougie. Bronchial aspirate obtained after bouginage was examined histologically in the hope that fragments of malignant tissue might have been dislodged, but in practice this technique proved to be unsuccessful.

Complications

In the total of 1,109 bronchoscopic examinations there were one fatal and three non-fatal complications.

Fatal Complications.—A man aged 66 died 10 hours after bronchoscopy. He had severe emphysema in addition to a bronchogenic carcinoma, and death was due to carbon dioxide narcosis, possibly contributed to by the presence of extensive cerebral metastases. The severity of his emphysema had not been correctly assessed and he was given a standard dose of omnopon and hyoscine. After the bronchoscopy his pulmonary ventilation was depressed and he rapidly became comatose. He died without recovering consciousness despite the administration of N-allylnormorphine, nikethamide, and aminophylline.

Non-fatal Complications.—(*a*) Of local analgesia:—No patient developed symptoms attributable to either of the two local analgesic agents employed. (*b*) Of bronchoscopy itself: A woman aged 63 developed respiratory obstruction from oedema glottidis 14 hours after bronchoscopy and required tracheostomy. She subsequently made a complete recovery. (*c*) Of bronchial biopsy:—Two patients had an abnormal degree of haemorrhage which continued for about half an hour after biopsy, in both instances after tissue had been taken blindly from within a basal bronchus. The airway was maintained by constant aspiration of the blood until the haemorrhage ceased spontaneously.

Pneumothorax and mediastinal emphysema resulting from perforation of the bronchial wall did not occur in this series, but outside the period under review a pneumothorax was recorded twice, each time after "blind" biopsy, and mediastinal emphysema once, after biopsy of a fibrous stenosis of the left lower bronchus. The pneumothorax in both cases was shallow and caused no symptoms. The mediastinal emphysema was accompanied by gross subcutaneous emphysema in the chest, neck, and face, but this subsided completely within a few days.

Based on the final diagnosis, the 980 patients available for detailed analysis can be divided into four groups: (1) bronchogenic carcinoma, 276; (2) bronchiectasis, 118; (3) pulmonary tuberculosis, 132; (4) other conditions, 458.

A dual diagnosis of pulmonary tuberculosis and bronchogenic carcinoma in four cases accounts for the figures totalling 984 instead of 980.

The results of bronchoscopic examination in the first three groups are reviewed in detail, but only a brief account is given of the fourth group, as few of these cases showed any abnormality at bronchoscopy.

Value of Bronchoscopy in Specific Conditions.

1. Bronchogenic Carcinoma

800 patients in whom a bronchogenic carcinoma was suspected were submitted to bronchoscopic examination. The diagnosis was finally established in 276 (34%). Histological evidence of carcinoma was obtained by bronchial biopsy in 168 (61%) of the 276 cases. Bronchoscopic examination was of no diagnostic value in 75 cases (27%), and of only limited value in an additional 33 cases (12%), in which the macroscopic appearances were consistent with tumour but biopsy was negative.

In an attempt to evaluate the factors influencing the results of bronchoscopic examination in patients with bronchogenic carcinoma the macroscopic appearances and the results of bronchial biopsy were analysed in relation to (*a*) the radiographic changes, and (*b*) the occurrence of haemoptysis. Finally, we tried to show how the results of bronchial biopsy were influenced by the macroscopic appearances at bronchoscopy.

Results of Bronchoscopic Examination in Relation to Radiographic Findings

Table I relates the frequency of macroscopic abnormalities at bronchoscopy and the results of bronchial biopsy to the type and situation of the lesion shown on the radiographs. The terms "normal" and "abnormal" in relation to bronchoscopy refer to the macroscopic appearances irrespective of the results of bronchial biopsy, which are shown separately. Radiographic classification is based on the interpretation of postero-anterior and lateral films.

TABLE I.—*Bronchogenic Carcinoma. Analysis of the Results of Bronchoscopic Examination in Relation to the Radiographic Findings*

	Bronchoscopy		Total	Positive Bronchial Biopsy
	Normal	Abnormal		
Type of radiographic abnormality:				
Atelectasis ..	11	82 (88%)	93	77 (83%)
Uniform opacity	17	49 (74%)	66	37 (56%)
Patchy opacities	10	22 (69%)	32	18 (56%)
Peripheral opacity	44	19 (30%)	63	19 (30%)
Hilar opacity ..	5	11 (69%)	16	11 (69%)
No radiographic abnormality	0	6	6	6
Total ..	87 (32%)	189 (68%)	276	168 (61%)
Anatomical situation of lesion on radiograph:				
Right upper lobe	26	39 (60%)	65	35 (53%)
,, middle ,,	3	8 (73%)	11	7 (63%)
,, lower ,,	9	48 (84%)	57	41 (72%)
Left upper ,,	37	34 (48%)	71	28 (39%)
,, lower ,,	5	37 (88%)	42	35 (83%)
Hilar region ..	5	11 (69%)	16	11 (69%)
Whole left lung	0	5	5	4
,, right ,,	2	1	3	1
No radiographic abnormality	0	6	6	6
Total ..	87	189	276	168
Haemoptysis present	29	93 (76%)	122	88 (72%)
,, absent	58	96 (62%)	154	80 (52%)
Total ..	87	189	276	168

"Normal" and "abnormal" bronchoscopy refer to the macroscopic appearances of the bronchi only.

With regard to the type of radiographic abnormality there was a striking contrast between the proportion of abnormal bronchoscopic findings in patients with radiographic evidence of atelectasis (88%) and those with a circumscribed peripheral opacity (30%). The figures for a uniform lobar or segmental opacity (74%) and for patchy lobar or segmental opacities (69%) were, however, only slightly lower than those for atelectasis. In the last group of six cases,

shown in Table I, bronchoscopic evidence of tumour was found in the absence of any radiographic abnormality.

The anatomical situation of the lesion on chest radiography also influenced the proportion of abnormal bronchoscopic findings. The examination was of much greater diagnostic value in tumours of the right lower lobe (84%) and the left lower lobe (88%) than in tumours of the right upper lobe (60%) and the left upper lobe (48%), the figure for the right middle lobar tumours (73%) and hilar tumours (69%) being intermediate.

The proportion of cases in which a positive biopsy was obtained showed a similar correlation with the type and the site of the radiographic abnormality (Table I). The highest figure was recorded in cases with atelectasis (83%). Those for a uniform lobar or segmental opacity (56%), patchy lobar or segmental opacities (56%), and a hilar opacity (69%) were slightly lower, but in patients with a circumscribed peripheral opacity a positive biopsy was obtained in only 30%. Tumours of the lower lobes more often yielded a positive biopsy (right 72%, left 83%) than tumours of the upper lobes (right 53%, left 39%). The figure for right middle lobar tumours was 63%.

Results of Bronchoscopic Examination in Relation to Occurrence of Haemoptysis

The relationship between haemoptysis and the bronchoscopic findings is also shown in Table I. Of the 276 patients with bronchogenic carcinoma, 122 (44%) gave a history of haemoptysis: 93 (76%) of them had a macroscopic abnormality at bronchoscopy as compared with 96 (62%) of the 154 patients without haemoptysis. This difference is not statistically significant. In most cases the haemoptysis was slight but repeated, often occurring daily, usually in the mornings, for a week or longer. Of the six cases of bronchogenic carcinoma with normal chest radiographs five had haemoptysis, which was the sole indication for bronchoscopy, and the sixth had a paralysed vocal cord.

Results of Bronchial Biopsy in Relation to Macroscopic Appearances at Bronchoscopy

When tumour tissue was visible at bronchoscopy, bronchial biopsy was positive in 94% of cases (Table II). When a bronchus was completely stenosed but no actual tumour tissue was visible the figure was only slightly lower (85%). When, however, the stenosis was incomplete, it fell sharply to 39%. In the 87 cases with no visible abnormality at bronchoscopy, biopsy was performed in 62 and a positive result was obtained in 12 (20%). This surprisingly high figure was achieved by the technique of "blind biopsy" already described. The 25 cases in which biopsy was omitted were all investigated before the value of "blind biopsy" was appreciated.

TABLE II.—*Bronchogenic Carcinoma. Results of Bronchial Biopsy in Relation to Macroscopic Appearance at Bronchoscopy*

Biopsy	Visible Tumour	Complete Stenosis	Partial Stenosis	No Macroscopic Abnormality	Total
Positive..	125 (94%)	17 (85%)	14 (39%)	12 (20%)	168 (61%)
Negative	8 (6%)	3 (15%)	22 (61%)	50 (80%)	83 (30%)
Total	133 (100%)	20 (100%)	36 (100%)	62 (100%)	251 (91%)
Not taken	—	—		25	25 (9%)

The manner in which the diagnosis of bronchogenic carcinoma was confirmed in the 108 cases in which a bronchial biopsy was negative or was not performed is shown in Table III.

TABLE III.—*Manner in which a Diagnosis was Made in the* 108 *Cases of Bronchogenic Carcinoma with a Negative Bronchial Biopsy*

Histological Evidence		*Clinical Evidence*	
Cervical gland biopsy ..	15	Metastases elsewhere ..	20
Axillary ,, ,, ..	2	Paralysed vocal cord or diaphragm	3
Skin biopsy	3	Progressive weakness and death	20
Carcinoma at thoracotomy	33		
,, ,, necropsy	12		

The prospects of obtaining confirmation of a diagnosis of bronchogenic carcinoma by bronchoscopy and bronchial biopsy are influenced by three factors: (1) the type of radiographic abnormality, (2) the anatomical site of the tumour, and (3) the nature of the bronchial lesion.

Type of Radiographic Abnormality

When there is definite radiographic evidence of atelectasis a significant abnormality is almost invariably seen at bronchoscopy. The usual finding in this type of case is complete obstruction of the related bronchus either by tumour tissue within the lumen or by compression and invasion of the bronchial wall by surrounding tumour. Bronchial biopsy in these circumstances is technically easy and usually positive. With either a uniform or patchy lobar or segmental opacity the bronchoscopic abnormalities are similar to those found with atelectasis, but bronchial obstruction is more often incomplete, in which case tissue for biopsy may be difficult to obtain and negative results are rather more frequent.

With a circumscribed peripheral opacity, as would be expected, the bronchoscopic appearances are often normal. In a few cases, however, one of the larger bronchi may be compressed or invaded by a metastatic gland or by a proximal peribronchial extension of the tumour. In such cases an abnormality will be seen at bronchoscopy and a positive bronchial biopsy may be obtained. Even when the bronchoscopic appearances are completely normal, however, histological proof of the diagnosis may be obtained by "blind biopsy." Accurate radiographic location of the lesion is vitally important to ensure that the tissue is taken from the lobe or segment involved. "Blind biopsy" is not devoid of risk, as perforation of the bronchial wall may result in severe haemorrhage from a bronchial artery, pneumothorax, or mediastinal emphysema. Evidence that a bronchus has been perforated is occasionally provided by the presence of lung tissue in the biopsy specimen. If, however, facilities are readily available for the treatment of these complications, the danger to the patient is slight and is more than offset by the valuable assistance a positive biopsy can provide in the patient's future management.

When the radiographic abnormality is a true hilar opacity —that is, not merely a pulmonary opacity superimposed upon a normal hilar shadow—bronchoscopic examination often shows a significant abnormality. In this group of cases the earliest finding is narrowing of one of the major bronchi, often a main bronchus, by external pressure from malignant glands. Bronchial biopsy is difficult and sometimes negative at this stage. In many cases, however, the glands have ulcerated through the bronchial wall by the time bronchoscopy is undertaken. Frank tumour tissue can then be seen and a positive biopsy is readily obtained.

In our six recorded cases of bronchogenic carcinoma showing no abnormality of the chest radiograph the lesion in five cases involved the main carina and one or both main bronchi, but in one case it involved the carina between the right middle and lower bronchi. The nature and the situation of the lesions suggested that they were due to invasion of the bronchial wall by malignant glands. The feature common to these six cases and, presumably, to all other cases of bronchogenic carcinoma with normal radiographic findings is the absence of any important degree of bronchial obstruction, which, if present, would, of course, produce a radiographic abnormality.

Anatomical Site of Tumour

As the upper bronchi are less readily accessible to bronchoscopic vision, it is not surprising that tumours in the upper lobes were, in this series, less frequently detected by bronchoscopic examination than those in the middle and lower lobes. In general, the left upper bronchus is slightly more difficult than the right to examine with reflecting telescopes, particularly if the lobe is shrunken, and this is presumably the reason why bronchoscopic examination was less informative in the detection of upper lobe tumours on the left side (48%) than on the right (60%). The same

general observations apply to bronchial biopsy. Although the use of lateral biting forceps undoubtedly facilitates the removal of tissue from within the upper bronchi, the right apical and the left apico-posterior segmental orifices can seldom be reached even with those forceps unless the upper bronchus is displaced downwards. Tumour tissue in the main, intermediate, and lower bronchi, on the floor of the upper bronchi, and within the orifices of the lingular, middle, and basal bronchi can be easily removed with "straight" forceps, but the lateral biting type is preferable for biopsy from within the upper and apical (lower) bronchi, and from a partially stenosed main, intermediate, or lower bronchus.

Nature of Bronchial Lesion

In certain types of bronchial lesion problems of interpretation may arise. For example, a lower bronchus partially stenosed by surrounding tumour may be difficult to distinguish from a normal but unusually narrow lower bronchus, a phenomenon which is commoner on the left side and is sometimes related to the presence of a pleural effusion. In such cases it should be borne in mind that the lumen of a malignant bronchial stenosis, unlike that of a normal bronchus, is seldom truly circular and does not show the normal variation in calibre with respiration.

Abnormal rigidity of the main, intermediate, or lower bronchi due to peribronchial infiltration by tumour can undoubtedly be detected with the bronchoscope; but this does not provide reliable evidence of malignant disease, and too much significance should not be attached to it unless it is accompanied by bronchial narrowing.

Subcarinal widening by malignant bifurcation glands, an important contraindication to thoracotomy, may also present difficulties in interpretation. Points of value in confirming the presence of this abnormality are asymmetry of the widening on the two sides, narrowing of the lumen of one or both main bronchi, and local protuberances caused by neighbouring glands at the junction of the anterior or posterior ends of the main carina with the bronchial wall.

Bronchial biopsy is technically easier and its results are more reliable when the specimen is taken from frank tumour tissue or a complete bronchial stenosis than when taken from a partial stenosis. The likely reason for this is that with a partial stenosis the tumour, which in these cases is usually invading the bronchus from its external aspect, may not have penetrated the whole thickness of the bronchial wall and therefore will not be included in the biopsy specimen unless a deep bite can be taken.

It may perhaps seem rather surprising that every biopsy of frank intrabronchial tumour tissue in our series was not positive. The occasional negative results in such cases were probably due to superficial necrosis of the intrabronchial portion of the tumour rendering it histologically unrecognizable. This difficulty can be overcome by removing the necrotic material gently by suction and then taking tissue deeply from the tumour mass. If the specimen sinks in saline it is unlikely to be necrotic.

The significance of a negative bronchoscopic examination in the exclusion of tumour may be extremely difficult to assess. In only one type of case (a patient with a normal chest radiograph who is submitted to bronchoscopy on account of haemoptysis) is a negative finding completely reassuring. In general, a diagnosis of tumour is very improbable if the bronchus supplying an atelectatic lobe or segment is clear, but such a conclusion is not valid in every case. With patchy lobar and segmental opacities, which in cases of bronchogenic carcinoma are usually due to pulmonary infection distal to a partial bronchial obstruction, a negative bronchoscopy virtually excludes tumour provided there is no associated hilar enlargement and the pulmonary opacity clears completely on chemotherapy. A uniform lobar or segmental opacity without atelectasis, although generally due to infection, is occasionally produced by a tumour mass occupying a whole lobe or segment, and in such cases a negative bronchoscopy may be of little diagnostic value. With a true hilar opacity and a circumscribed peripheral opacity negative findings at bronchoscopy are of no significance whatever in the exclusion of tumour.

In view of the fact that tumours of the lower and middle lobes are easier to detect than those involving the upper lobes, negative bronchoscopic findings can be more readily accepted as evidence against a diagnosis of tumour when the radiographic abnormality is in the middle lobe or in one of the lower lobes.

2. Bronchiectasis

There were 118 patients shown by bronchography to have bronchiectasis. These patients were also examined by bronchoscopy as part of the investigation of their respiratory symptoms. In most cases bronchoscopy was carried out immediately before bronchography to ensure that the bronchi were clear of secretions. Apart from this purely technical indication the reason for bronchoscopy in these cases was to discover whether the bronchiectasis was secondary to an obstructive lesion in a main bronchus such as a tumour or a fibrous stenosis.

In neither respect has bronchoscopy been of much positive value. The general standard of bronchography was not improved by preliminary bronchoscopy, and an abnormality of a major bronchus was found in only 3 of the 118 cases. In each case the lesion was a fibrous stricture of a lower bronchus; all three patients were men over 50. In all three the stricture was clearly shown on the bronchogram and would not have been overlooked had bronchoscopy been omitted.

These observations suggest that bronchoscopy is not a very profitable routine investigation in bronchiectasis. If, however, surgical treatment is contemplated bronchography should invariably be supplemented by bronchoscopy, as failure to discover a fibrous stenosis in a major bronchus might seriously prejudice the result of the operation.

3. Pulmonary Tuberculosis

Bronchoscopy was performed in 132 patients with pulmonary tuberculosis, in 89 to exclude tumour and in 43 to exclude endobronchial tuberculosis.

Of the 89 patients in whom a diagnosis of tumour was suspected, 68 were examined by bronchoscopy because the radiographic appearances were in keeping with either tuberculosis or tumour and because tubercle bacilli had not at the time been isolated from the sputum. A further nine had tubercle bacilli in the sputum before bronchoscopy, but the abnormality of the chest radiograph was so suggestive of tumour that a double diagnosis was suspected. In three patients, despite a negative sputum, a confident diagnosis of tuberculosis had been made from the chest radiograph, but it was subsequently deemed necessary to carry out bronchoscopy in view of a poor response to chemotherapy. In eight patients slight haemoptysis raised the suspicion of a tumour, although the radiographic abnormalities were merely those of minimal, apparently inactive, tuberculosis. The indication for bronchoscopy in the remaining patient, with an old-standing fibrotic tuberculous lesion, was peripheral neuropathy thought to be based on malignant disease.

In this group of 89 patients tumour was found at bronchoscopy in three. Two of these developed new opacities in the chest radiograph after the completion of treatment for active pulmonary tuberculosis. They were submitted to bronchoscopy, as sputum examination was negative for tubercle bacilli and the radiographic appearances were more suggestive of tumour than of a reactivation of tuberculosis. The third patient developed a new opacity in the right upper lobe while still receiving antituberculous chemotherapy, although the opacities elsewhere were improving and the sputum had become negative. In a fourth patient bronchoscopy was normal but a diagnosis of bronchogenic carcinoma was subsequently made by rib biopsy. He had presented with what appeared to be a tuberculous cavity at the right lung apex with fibrotic tuberculous shadowing in the left upper lobe. In only four other patients in this group was bronchoscopy abnormal. The

findings in these patients were ulcerating tuberculous glands (two cases), bronchial stricture, and atresia of the left lower bronchus.

Of the 43 patients in whom a diagnosis of tuberculosis had already been established and who were examined by bronchoscopy on account of suspected bronchial complications, nine showed significant abnormalities. In five patients there was evidence of glandular ulceration through the bronchial wall. In a further patient a bronchus was compressed by a gland but not ulcerated, and in three others a healed bronchial stricture was found.

Of the total of 132 cases of pulmonary tuberculosis submitted to bronchoscopy, 89 were classified as active (70 sputum-positive) and 43 inactive. In 8 (9%) of the active cases there was bronchial involvement secondary in every instance to glandular ulceration. This figure, of course, relates to a highly selected group and in no way represents the real incidence of bronchial complications of pulmonary tuberculosis, which must be very much lower. None of the patients had acute tuberculous endobronchitis. A bronchial stricture, probably related to a previous tuberculous infection, was found in four cases, one with active and three with inactive pulmonary tuberculosis.

Value of Bronchoscopic Examination in Patients with Pulmonary Tuberculosis

There were three positive results in the 89 bronchoscopic examinations to exclude tumour (3.4%). The large number of negative examinations is undoubtedly a reflection of our anxiety not to overlook a tumour. The same cautious attitude is also responsible for the fact that in no fewer than 9 of the 86 patients without evidence of tumour at bronchoscopy the possibility of malignant disease was considered strong enough to warrant thoracotomy. If we had been prepared to wait a few weeks for a positive culture of the sputum for tubercle bacilli 35 patients might not have required bronchoscopy or thoracotomy. In some cases, however, a delay of this length might have had serious consequences. Moreover, the radiographic appearances in many of our other patients with proved tumours were consistent with tuberculosis, and, if the indications for bronchoscopy in this type of case had been relaxed, errors and delays in diagnosis would have been much more numerous. This consideration, together with the results of work by Sakula (1955), who concluded that a combination of tuberculosis and tumour was more frequent than could be accounted for by chance association, has convinced us that our present policy is correct, and we would be reluctant to alter it.

The commonest abnormality found on bronchoscopic examination of tuberculous patients in this series was bronchial ulceration by caseous glands complicating a primary tuberculous infection. Tuberculous endobronchitis in association with post-primary pulmonary tuberculosis was not seen. Although there has undoubtedly been a sharp decline in the prevalence of this condition in recent years the total absence of this type of bronchial lesion in our series could equally well be explained by the nature of the clinical material, in that few of the patients had large numbers of tubercle bacilli in the sputum, and some had received antituberculous chemotherapy for a few weeks before bronchoscopic examination.

A bronchial stricture, presumably of tuberculous origin, is a not uncommon incidental finding at bronchoscopy.

4. Other Conditions

The final diagnosis in the 458 patients outside the three main groups already discussed was as follows:

Pneumonia	136	Benign pulmonary atelectasis	13
Chronic bronchitis	100	Pulmonary infarction	12
Haemoptysis—cause not determined	57	Sarcoidosis	11
Pleural effusion or empyema (non-malignant)	28	Metastatic pulmonary tumours	11
Benign tumours and cysts	16	Spontaneous pneumothorax	7
		Miscellaneous conditions	67

By far the commonest reason for bronchoscopy in these cases was to exclude a bronchogenic carcinoma, which had been suspected from (*a*) the symptoms—for example, haemoptysis; (*b*) the clinical features—for example, finger-clubbing; (*c*) the radiographic appearances; or (*d*) an unsatisfactory response to treatment.

Pneumonia.—In some cases of pneumonia bronchoscopy was advised where there was slow or incomplete resolution of the consolidation after adequate chemotherapy. Bronchoscopy was usually confined to such cases, as in our experience complete clearing of consolidation on the chest radiograph is very seldom associated with an underlying tumour, and it is clearly impracticable to examine by bronchoscopy every patient with pneumonia.

Chronic Bronchitis.—Haemoptysis is a common feature in chronic bronchitis. It is also, however, a frequent presenting symptom in bronchogenic carcinoma, and this largely accounts for the fact that we submitted to bronchoscopy 100 patients in whom no abnormality other than chronic bronchitis was eventually found. Another factor contributing to the frequency of bronchoscopy in chronic bronchitis was the large number of such patients who on account of repeated respiratory infections showed on chest radiography pulmonary opacities and pleural thickening, consistent with the presence of a tumour. It is impracticable to investigate by bronchoscopy every patient with chronic bronchitis who develops haemoptysis or has a radiographic opacity. Some degree of selection must be exercised. In the case of haemoptysis, however, bronchoscopy must always be advised when the bleeding persists for a few days.

Haemoptysis—Cause Not Determined.—Although bronchoscopy was negative in 57 patients who presented with haemoptysis and a negative chest radiograph in the absence of chronic bronchitis, five other patients in the same category were found to have tumours. For this reason we now regard haemoptysis as a more compelling indication for bronchoscopy if the patient does *not* give a history of chronic bronchitis.

Pleural Effusion.—There were 52 cases of either pleural effusion or empyema in the series of 980 bronchoscopic examinations. Twenty-four had an underlying bronchogenic carcinoma, but in only four was the pleural abnormality due to malignant involvement. In the other 28 cases the pleural effusion was simple inflammatory in origin, usually tuberculous. Bronchoscopy was carried out in these patients either because they were in the older age groups or because there was insufficient evidence to support a tuberculous aetiology.

Benign Tumours and Cysts.—The indication for bronchoscopy in all cases was a radiographic opacity in the lung or mediastinum. Four cases of bronchial adenoma were included among the benign tumours, but in only one was the diagnosis made by bronchoscopy. In the remaining three the tumour was situated peripherally in the lung.

Other Cases.—The remaining cases were examined by bronchoscopy for a variety of reasons. In pulmonary infarction, for example, the combination of haemoptysis and a pulmonary or pleural opacity often suggested the presence of a tumour. In spontaneous pneumothorax a persistently atelectatic lobe was the usual indication. The patients who eventually proved to have benign pulmonary atelectasis, sarcoidosis, or metastatic pulmonary tumours required bronchoscopy because the radiographic appearance could not be distinguished from that of a primary bronchogenic carcinoma.

Significance of Haemoptysis with a Normal Chest Radiograph

In our survey 93 patients had a normal chest radiograph following haemoptysis, and a bronchogenic carcinoma was found at bronchoscopy in five. In none of the 38 patients aged 40 or under was a tumour found, but in the 55 patients over the age of 40 a tumour was seen in five. If the chest radiograph in each of these five cases was indeed normal this would emphasize the danger of accepting a normal chest radiograph as excluding a bronchogenic carcinoma.

An attempt was therefore made to determine whether the chest radiographs of the five patients (seen between 1952 and 1956) were considered normal by those accustomed to interpreting chest radiographs. This investigation is reported in detail elsewhere (Somner and Sklaroff, 1958). The five radiographs were presented to 18 observers along with those from three similar cases encountered during 1957 (not included in the general analysis in this paper) and that of a ninth patient who presented with a paralysed vocal cord but without haemoptysis. The observers were asked to review these nine radiographs along with 60 others (in random order) from patients also with haemoptysis who had been examined by bronchoscopy to confirm or exclude a bronchogenic carcinoma.

Although we classified fewer hilar shadows as enlarged than the panel of observers *as a whole*, there was no evidence that our classification of "normal" hilar shadows was different from that of the *majority of observers*. Moreover, since the 18 observers did not need to make clinical decisions, they may have been inclined to be more positive in their assessment of abnormality. It is therefore concluded that our standard of interpretation of a normal hilar shadow was similar to that found among the group of observers.

The final diagnosis in the 93 cases was as follows: bronchogenic carcinoma, 5; hypertension, 7; bronchitis, 20; bronchiectasis, 9; mitral stenosis, 1; foreign body, 1; no cause, 50.

In view of the relative frequency of bronchogenic carcinoma in this group of cases we consider it advisable that all patients with haemoptysis, especially males over the age of 40, should be examined by bronchoscopy to exclude bronchogenic carcinoma even when the chest radiograph is normal, unless there is some pre-existing respiratory or cardiovascular disease which could possibly account for it.

Summary

In an attempt to clarify the indications for bronchoscopy, in particular where there is a possibility of bronchogenic carcinoma, an analysis was made of 1,109 patients examined during 1952 to 1956.

In 276 patients with a bronchogenic carcinoma the results of bronchoscopic examination and bronchial biopsy were analysed in relation to the radiographic appearances and the presence or absence of haemoptysis. A visible abnormality at bronchoscopy was found in 189 (68%) and histological evidence of the disease was obtained by bronchial biopsy in 168 (61%). The value of "blind" biopsy in obtaining histological evidence of carcinoma when the bronchoscopic appearances were normal is stressed. The diagnostic value of bronchoscopy was found to be related both to the type of radiographic abnormality and to its anatomical situation. The finding of an abnormality at bronchoscopy was not in general related to the presence or absence of haemoptysis, but in six patients with tumours and a normal chest radiograph haemoptysis was the presenting feature in five.

In the 118 cases of bronchiectasis reviewed it was concluded that bronchoscopy was not an essential part of the investigation unless surgical treatment was contemplated. Out of 132 cases of pulmonary tuberculosis examined by bronchoscopy an active endobronchial lesion was found in six patients with primary tuberculosis and a bronchogenic carcinoma in three.

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TATTOOING IN THE SERVICE OF SURGERY

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The practice of tattooing (Polynesian, *ta tau*, to mark) is undoubtedly of very ancient, prehistoric origin. In caves in Western Europe hollowed stones for grinding coloured clays are to be found; such colours were, and indeed in some regions still are, used for surface decoration (cp. woad in Britain), but it seems likely that, perhaps as the result of an accident, it was discovered that the implantation of the clay, or of charcoal from a fire, into a cut or puncture produced a permanent pattern which avoided frequent renewals. An early historical reference to the practice is to be found under the Mosaic Law in Leviticus, xix. 28, "Ye shall not make any cuttings in your flesh . . . nor print any marks upon you."

Early Tattooing

Although at first probably purely decorative, tattooing later acquired religious, tribal, and social significance, or in some cases was merely of horrific intent. The cult

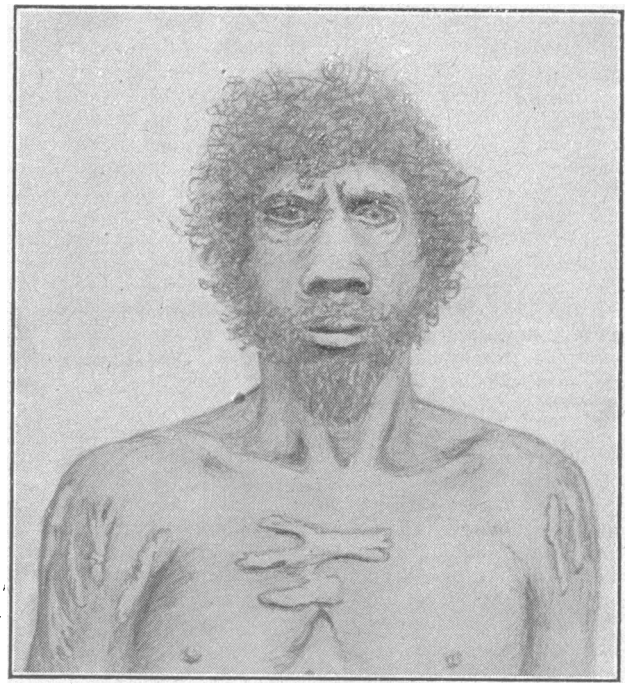

FIG. 1.—Keloid scar tattooing on an Australian aboriginal produced by the method described in the text.

varied greatly. Thus in Polynesia it was a mark of puberty; among Arabs, infants were tattooed as a simple ornament or means of recognition; for the American Indians and the Australians it was a sign of the tribe or family; while the Kaffirs employed it as a decoration for bravery. The most extensive tattooing is found on the Laos of Indo-China, where the division into "black paunch" and "white paunch" areas depends upon the tattooing of the abdominal wall, but, in addition, the thighs, legs, and breasts are often completely covered with fantastic animal figures. In