

known, the third important eye scope was devised. This was the slit lamp biomicroscope, which permits detailed examination of lesions that could not be seen before. Recent models combine higher powers of magnification with better illumination. By means of special illumination Zeitz perfected the photographing biomicroscope for photographing the capillaries of the conjunctiva. The ocular conjunctiva presents a perfect field for the clinician to study capillaries in the living state, to observe circulation, and to see under high power evidence of the activity of the vascular tree. The physiology and pathology of a large portion of the capillary bed may be observed.

Through the development of the ophthalmoscope and allied instruments examination of the eye has been facilitated. The use of these instruments by the general practitioner may further extend his ability to diagnose earlier and more accurately certain general diseases.

## BRONCHOSCOPY

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Strictly speaking, bronchoscopy is limited to the visual examination of the bronchi and originally was used to remove foreign bodies from the air passages. In its broader connotation it has even greater usefulness in the diagnosis and treatment of diseases of the entire tracheobronchial tree.

Jackson has been largely responsible for developing the technic of bronchoscopy to its present high efficiency. Because bronchoscopy seemed a formidable procedure, the general practitioner was slow to realize that the bronchoscope provided a means for diagnosing obscure pulmonary disease. Recent advances in thoracic surgery have emphasized the importance of bronchoscopy in early diagnosis, and consequently greater responsibility has been placed upon the endoscopist. This paper urges wider application of bronchoscopy to diseases of the tracheobronchial tree, not only obscure ones, but also many of the more common conditions which may be secondary to undiagnosed and more important pathologic conditions.

Bronchoscopy is closely related to the development of direct laryngoscopy and esophagoscopy. In 1897 Killian removed a foreign body from the bronchus through an esophagoscope and demonstrated the feasibility of lower bronchoscopy. The first authentic use of the bronchoscope in the United States was in 1897 by Coolidge, who re-

moved a fragment of tracheal cannula from the right bronchus. In 1905 Chevalier Jackson perfected a distally lighted tube that eliminated blind bronchoscopy and made possible the use of narrower and safer tubes.

Bronchoscopy is indicated when signs and symptoms related to the trachea, bronchi, and lungs cannot be explained by the physical findings, x-ray examination, and laboratory studies. Bronchoscopy is particularly indicated in unexplained rhonchi, râles, and localized dulness; in paralysis of recurrent laryngeal or phrenic nerve; and when x-ray examination reveals bronchial obstruction, atelectasis, emphysema, infiltration, cavitation, and mediastinal root shadows. Symptoms calling for bronchoscopy are unexplained cough with or without expectoration, hemoptysis, wheezing, chest pain, and dyspnea.

In the presence of a **foreign body** in the air passages the symptoms and findings are relative to the size, shape, chemical composition, and length of time the body has been lodged in the respiratory tract. The symptoms may simulate those of chronic bronchitis, asthma, bronchiectasis, emphysema, or atelectasis.

The possibility of a foreign body in the tracheobronchial tree should be suspected in any case of acute or chronic pulmonary suppuration. The following case report of chronic pulmonary suppuration due to a foreign body opaque to x-ray but not visible on a roentgenogram of the chest illustrates the value of bronchoscopy in diagnosis and treatment.

**Case 1**—A white man, aged 49, came to the Clinic on December 14, 1942 complaining of chronic cough productive of foul mucopurulent sputum present for four months. There was no chest pain, shortness of breath, nor hemoptysis, but there had been a loss in weight of 14 pounds since the onset of the illness. The illness began with a severe chill followed by fever, which confined him to bed for fifteen days. After x-ray examination of the chest a diagnosis of pleurisy was made. The patient recalled choking while eating chicken soup two days preceding the chill.

The patient was pale and emaciated and appeared chronically ill. The temperature was 99.4 F. There was some limitation of costal excursion on the right with diminished breath sounds and dulness to percussion over the right lower chest.

X-ray examination of the chest revealed that the right diaphragm was slightly elevated and partly obscured. Increased density of the right hilar shadow and of bronchial shadows on the right lower lung field suggested an inflammatory lesion, probably bronchiectasis or lung abscess.

Examination of the blood revealed 4,100,000 red blood cells, 19,550 white blood cells, 71 per cent hemoglobin, and a blood sugar of 97 mg. per 100 cc. Blood sedimentation rate was 1.77 mm. per minute. Urinalysis was normal, and blood Wassermann and Kahn tests were negative.

Bronchoscopy disclosed the right main stem bronchus filled with foul yellow pus. After aspiration a foreign body partly covered with granulation tissue and completely

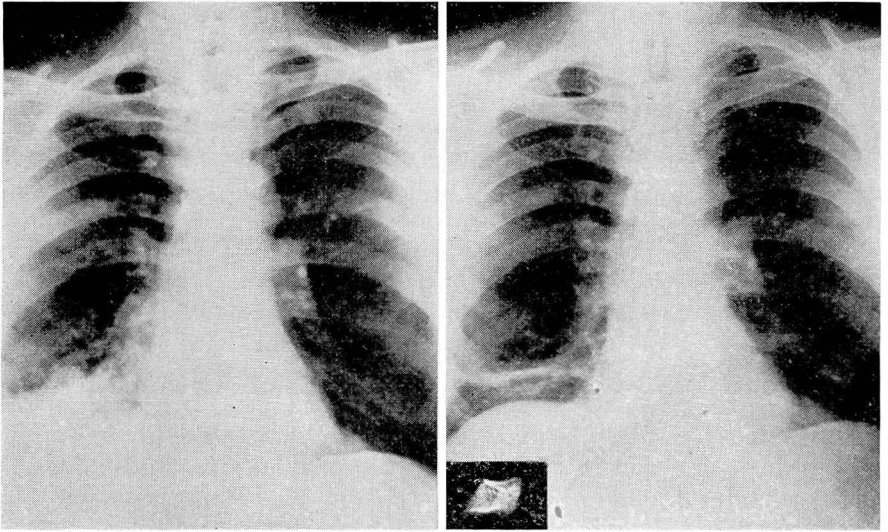


FIGURE 1

obstructing the lumen was encountered in the bronchus of the right lower lobe. The foreign body was anchored against the tip of the bronchoscope with grasping forceps and removed when the scope was withdrawn. The foreign body proved to be an irregular piece of dense cancellous bone. The entire bronchial tree below the area of obstruction was filled with pus. This foreign body was not visible on the roentgenogram of the chest but was found to be opaque to x-ray (fig. 1).

Postural drainage and a three weeks' course of sulfathiazole were prescribed. During the next two months the symptoms and the abnormal x-ray findings gradually disappeared.

In suspected **bronchogenic carcinoma** bronchoscopy with removal of tissue for biopsy affords a means of confirming the diagnosis and determining the operability of the case.

In **bronchiectasis** bronchoscopy is useful (1) in establishing the presence of obstructive lesions of the bronchi, such as foreign bodies, bronchial tumors, and bronchial stenosis and (2) in introducing lipiodol into the bronchial tree before bronchography to determine the presence and extent of the bronchiectatic process.

Lipiodol bronchography is an essential procedure in determining the advisability and extent of lung surgery. The method I have found most satisfactory in most children and some adults is the following:

After bronchoscopy and aspiration of pus a full length bronchoscopic suction tube is introduced into the bronchoscope. A 50 cc. syringe (Luer) containing the desired amount of lipiodol is introduced into the suction

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tube, which is guided by the bronchoscope into either the right or the left bronchial tree. The lower lobes are outlined by elevating the head of the table, and the upper lobes are outlined by elevating the foot of the table. Rotating the patient carefully to the right or the left helps to fill the bronchus under consideration (fig. 2).

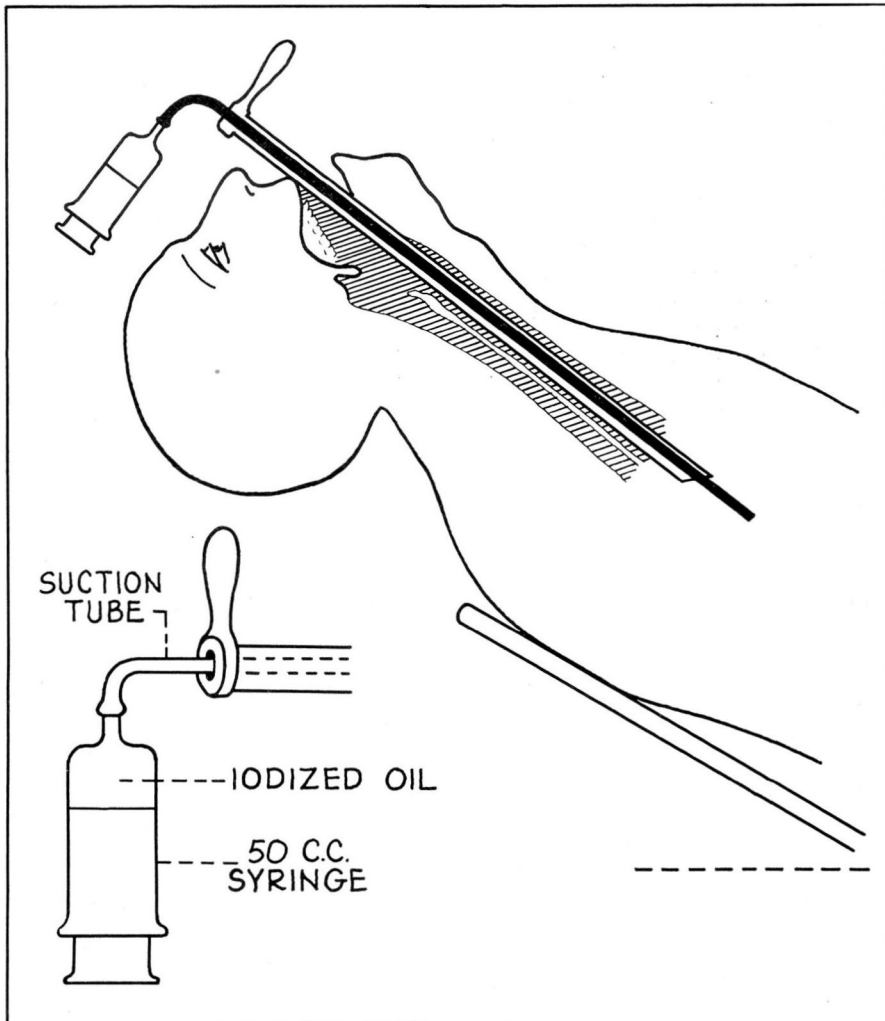


FIG. 2—Schematic diagram showing position of patient with bronchoscope in place. The suction tube is introduced through the bronchoscope and lipiodol instilled into the desired portion of the lung.

In the following case the bronchogram was made according to the described procedure.

**Case 2**—A boy, aged 8, came to the Clinic on July 25, 1944 complaining of chronic cough and purulent expectoration, which had been present for six and one-half years. A diagnosis of pneumonia was made several times. Hemoptysis was noted on several occasions after the last attack of pneumonia in February 1944. The mother reported that the child's appetite was poor and that he did not gain weight. She said that at birth there was "rattling" in the child's chest, more pronounced on the right side.

The child was pale, debilitated, and undernourished. He weighed 39.5 pounds. Oral temperature was 100 F. Chest examination revealed dullness to percussion over the right lower chest, high-pitched breath sounds, and coarse râles. X-ray of the chest showed extensive infiltration with thickened pleura at the base of the right lung, probably due to unresolved pneumonia.

Examination of the blood revealed 4,014,000 red blood cells, 9900 white blood cells, 75 per cent hemoglobin, and a blood sugar of 97 mg. per 100 cc. three hours after eating. The urine had a specific gravity of 1022, a Ph of 6.0, and was negative for albumin and sugar. Blood Wassermann and Kahn tests were negative.

Bronchoscopy was carried out under general anesthesia. The trachea was in the midline. The carina was sharp and vertical. The right main stem bronchus was partly filled with mucopurulent exudate, which was aspirated and found to be coming from the right lower lobe bronchus and its terminal branches. There was no bronchial obstruction to explain the bronchiectasis. The left bronchial tree was normal.

Twenty cubic centimeters of lipiodol was instilled into the right lower lobe bronchus and 10 cc. into the left lower lobe. The bronchogram revealed extensive saccular bronchiectasis of the right lower lobe (fig. 3).

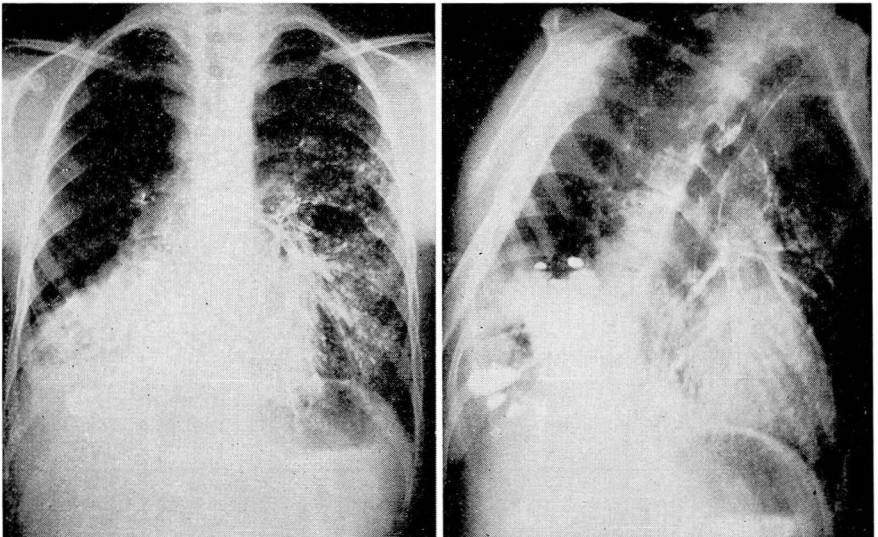


FIGURE 3

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Most cases of **bronchial asthma** can be diagnosed without bronchoscopy. However, when allergy management is not effective in the treatment of asthma, bronchoscopy is indicated, since lesions producing tracheal obstruction may produce symptoms simulating asthma.

In allergic patients caution should be exercised in the use of anesthetic agents. I prefer 2 per cent cocaine to any synthetic agent. Never more than 4 cc. should be used. There is a tendency to use too much of the local anesthetic agent in these cases, because the patient's cough reflex is hyperactive. Also the anesthetic applied to the tracheobronchial tree is less effective, probably because of edema of the mucosa and the presence of thick mucoid secretions.

In **status asthmaticus** mucoid secretions which the patient is unable to expel by coughing may be aspirated by bronchoscopic suction under local anesthesia. This procedure followed by avertin anesthesia will usually control the attack. Because of the danger of depressing respiration in an exhausted patient whose tracheobronchial tree is partly filled with mucus, avertin should be given after bronchoscopic aspiration and not before.

**Case 3**—A farmer, aged 63, was seen in consultation with an allergist because of persistent asthma (status asthmaticus). He was admitted to the hospital on February 2, 1944 during a severe attack of wheezing and shortness of breath which did not respond to the usual treatment. During the next ten days he received frequent injections of adrenalin 5 minims, adrenalin in oil, paraldehyde and chloral hydrate, and intravenous injections of aminophylline with only slight improvement. The asthma continued with varying severity for two weeks. The patient showed evidence of severe exhaustion, and response to medication became less effective.

Bronchoscopy was advised and was carried out under local anesthesia. Two cubic centimeters of 2 per cent cocaine was instilled into the trachea in 0.5 cc. amounts. A large quantity of mucus was aspirated from the trachea and from the main stem and terminal bronchi. The wheezing continued, but there was some improvement in the shortness of breath. The exhaustion and excitability remained unchanged. He was then given 75 mg. of avertin by rectum and in approximately twenty to thirty minutes was sleeping. He slept for three hours and remained drowsy for twelve hours without wheezing or air hunger. The attack subsided; a mild recurrence one week later was controlled with adrenalin.

Obviously it would have been unwise to give this patient avertin and depress his respiration when the tracheobronchial tree was partly filled with mucus.

The average case of **pulmonary tuberculosis** does not require bronchoscopy for diagnosis. However, the tubercule bacillus frequently cannot be demonstrated in the sputum of a patient suspected of having tuberculosis. When all other diagnostic methods fail, microscopic examination of aspirated bronchial secretions frequently reveals the acid-fast bacillus. Bronchoscopy is also indicated (1) in the presence of sputum

which remains positive in spite of adequate therapy to determine the presence of tracheobronchial tuberculosis, (2) before surgery to identify a bronchial lesion or positive sputum in the opposite lung, and (3) to identify the type of bronchial lesion.

**Pneumonia** recurring in a particular area of the lung is probably due to a bronchial lesion. The following case illustrates the importance of bronchoscopy in recurrent pneumonia.

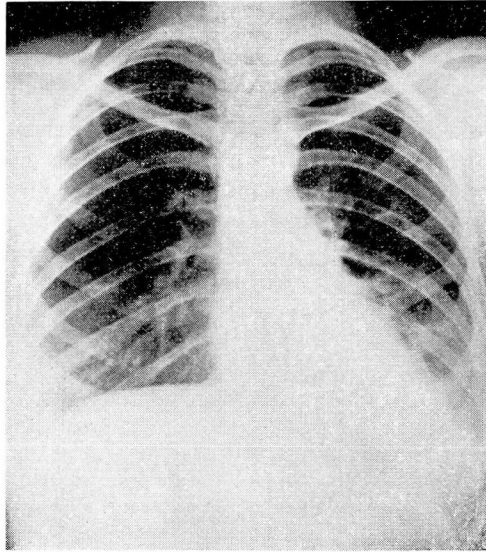


FIGURE 4

**Case 4**—A woman, aged 25, was admitted on October 11, 1944 with a history of eight attacks of pneumonia and pleurisy during the past eight years. She also complained of pain in the left lower chest and left shoulder which had developed two years before after an attack of pneumonia. Recovery from the pneumonia was slow. The chest pain was persistent and was aggravated by deep breathing and by lying down. A chronic cough was occasionally productive of mucopurulent sputum with streaks of bright red blood. The attacks of coughing were usually accompanied by chills and fever. Although tuberculosis was suspected, the sputum was never positive. There had been a gradual loss of weight from 130 to 95 pounds during the past two years.

Over the lower left chest posteriorly fine râles were heard with accompanying tenderness to pressure, dullness to percussion, and decreased breath sounds over the left base.

At x-ray examination of the chest, scattered through the lower left lobe were thin-walled cystlike cavities about 1.5 cm. in diameter surrounded by a homogenous density in the inferior portion of the lobe. The impression was of an inflammatory lesion with production of cysts in the left lower lobe, probably in the advanced stage. The diagnosis was bronchiectasis secondary to bronchial obstruction (fig. 4).

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Examination of the blood revealed 4,440,000 red blood cells, 6150 white blood cells, hemoglobin 84 per cent, and blood sugar 102 mg. per 100 cc. The urine had a specific gravity of 1010, a Ph of 6.5, and was negative for albumin and sugar. No specific organism was found in the sputum.

Upon bronchoscopy the left lower lobe was obstructed by a smooth, rounded and lobulated, reddish tumor mass. The tumor, which was attached to the left lateral wall of the left lower lobe bronchus just below the upper lobe orifice, was removed through the bronchoscope. Bleeding from the tumor area was profuse. The bronchial tree below the tumor was filled with pus, and approximately 50 cc. of foul thin yellow pus was aspirated. The gross appearance of the tumor was that of a bronchial adenoma. This was confirmed by microscopic examination.

The bronchoscopic diagnosis was bronchial adenoma of the left lower lobe bronchus with secondary bronchiectasis in the advanced stage. Early diagnosis and removal of the tumor would have prevented the development of the extensive bronchiectasis.

When **hemoptysis** is not definitely associated with pulmonary tuberculosis, mitral stenosis, aortic aneurysm, or pulmonary embolism, bronchoscopy is indicated. Even with bronchoscopy the cause of bleeding in many cases cannot be determined. Frequently unexplained hemoptysis results from trauma to the trachial and bronchial mucosa from violent coughing. Abnormal fragility of blood vessels of the bronchial mucosa may also be a factor and may be determined by exerting gentle pressure on the bronchus with the tip of the bronchoscope. Other causes of hemoptysis are mucous polyps, malignant neoplasm, bronchial adenoma, bronchiectasis, tracheobronchial tuberculosis, or erosion of the bronchial wall in the presence of a broncholith.

The patient with a chronic cough is the victim of a vicious cycle. The more he coughs, the greater the trauma to the larynx and tracheo-bronchial tree. Thus the cough tends to persist. Bronchoscopy is usually indicated in any **unexplained cough**, even though the majority of these cases may be reflex in origin. Only by such an examination will unusual lesions be discovered.

Bronchoscopy is indicated as soon after operation as **atelectasis** or massive collapse of the lung is suspected. If the mucoid secretions are aspirated early, the postoperative course may be uneventful. The procedure should be carried out within the first twenty-four hours; after thirty-six hours reexpansion of the lung is more difficult, and pneumonia is more apt to ensue.

I believe that in many cases of postoperative atelectasis saliva has been aspirated during operation. During every general anesthetic the anesthetist should have equipment for oral suction, preferably a metal tonsil suction tip. If large quantities of mucus or saliva collect in the trachea at the completion of operation, bronchoscopic aspiration should be carried out before the patient returns to his room. In many instances

the patient does not have the inclination or strength to cough out the secretions.

The regional lymph glands may become infected, enlarged, and later calcified producing **broncholiths**. Consequent pressure on the trachea or bronchi causes varying degrees of stenosis. The most common cause of broncholiths is tuberculous lymphadenopathy. Occasionally ulceration may occur in the lumen of the trachea and bronchi. This produces obstruction with severe paroxysmal coughing or hemoptysis. The broncholiths may be expelled spontaneously, but frequently they can be identified and removed through a bronchoscope.

Bronchoscopy is also of value in the diagnosis of anomalies of the tracheobronchial tree, bronchial and tracheal stenosis, and rare pulmonary infections such as actinomycosis, blastomycosis, and leptothrix infections.

#### SUMMARY

Although originally designed for the removal of foreign bodies, the bronchoscope has become an invaluable aid in diagnosis and treatment of many bronchopulmonary conditions. The procedure should not be reserved for obscure pulmonary disease but should be utilized when indicated in the more common ones as well, since many of these are secondary to undiagnosed lesions in the tracheobronchial tree.

Specific indications for bronchoscopy are

- |                                               |                                                              |
|-----------------------------------------------|--------------------------------------------------------------|
| 1. Foreign body in the tracheo-bronchial tree | 10. Broncholithiasis                                         |
| 2. Suspected bronchogenic carcinoma           | 11. Lung abscess                                             |
| 3. Bronchiectasis                             | 12. Tumor of the tracheobronchial tree, lung, or mediastinum |
| 4. Bronchial asthma                           | 13. Stenosis of the trachea and bronchi                      |
| 5. Unexplained hemoptysis                     | 14. Anomalies of the tracheobronchial tree                   |
| 6. Pulmonary tuberculosis                     | 15. Rare pulmonary infections such as syphilis and mycoses   |
| 7. Recurrent or unresolved pneumonia          |                                                              |
| 8. Unexplained cough                          |                                                              |
| 9. Postoperative atelectasis                  |                                                              |

In bronchiectasis endobronchial examination should always be done, and in children the bronchoscope affords an excellent means of introducing lipiodol into the desired portion of the lung after all available pus has been aspirated.

Advances made in thoracic surgery during recent years have placed new emphasis on the importance of endoscopy and greater responsibility on the medical profession for early diagnosis of the lesion.