Identification of Active Pulmonary Cavitary Disease by Barium Bronchogram Technique*

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Experience has demonstrated that the proper application of the chemotherapeutic and antibiotic agents now available for the treatment of pulmonary tuberculosis will result in the arrest of this disease in a majority of patients. Failure of the medical control of pulmonary tuberculosis as manifest by open cavity or sputum positive for tubercle bacilli, or both, has been accepted as indication for surgical intervention.1,2

During the past decade, the problem of the "open negative" tuberculous cavity has become apparent and created the obvious need to define whether this lesion is an indication for extirpation of the cavity-bearing pulmonary tissue, limited medical management, or continuous medical therapy. Some authors have defended the former course by detailing the incidence of reactivation of tuberculosis if the cavity is not surgically excised,3,4 while others have suggested that these cavities do not have surgical implication.5,6

While Auerbach and Small7 have defined pathologically the lesion that should be considered as an open-healed tuberculous cavity, Raleigh8 has most aptly questioned whether the residual annular shadows seen in the chest x-ray film represent tuberculous cavities, bullae, blebs, bronchiectatic dilatations or cysts. That bronchogenic cysts can simulate tuberculosis or actually become tuberculous lesions with superimposed acid-fast infections has been described.9 Fortunately, the majority of bronchogenic cysts can be identified during bronchography since the contrast medium flows easily into the cyst through several large bronchial communications.

The use of barium as a contrast medium for bronchography10 and the demonstration by Christoforidis et al11 of the "wall sign" in those patients with cavitary lesions ex-

Figure 1: Right bronchogram with micropaque barium suspension and carboxymethylcellulose on January 2, 1959. PA, left anterior oblique and lateral projections. Large thin walled cysts communicating with the bronchial tree are located in the posterior segment of the right upper lobe and superior segment of the right lower lobe.
In the present study, barium bronchogram was performed in 91 patients with cavitary pulmonary lesions. The contrast medium used was barium sulfate suspended in a solution of normal saline containing 1.75 per cent carboxymethylcellulose which was introduced through an intrabronchial coudé catheter properly positioned after 10 per cent lidocaine (Xylocaine) anesthesia. Filling of the tracheobronchial tree with the barium mixture was monitored by fluoroscopy during the period of examination with spot x-ray films being taken as indicated during the procedure and standard 14x17 x-ray films at the completion of the bronchogram. All 91 patients evaluated by this technique had been shown to have a cavity or cavity-like lesion by prebronchographic serial chest films and laminagrams.

In 43 patients, the cavity was filled with the barium suspension during the bronchogram. In 32 individuals, subsequent films taken after intervals of 24 hours to several weeks following bronchography, showed the thin line of barium in the wall of the cavity compatible with a positive "wall sign." That the barium sulfate had actually been phagocytized by the epithelioid cells in the wall of the cavity was verified in the resected surgical specimen. The final diagnoses established in these 43 patients were infected bronchogenic cysts in 11 (Fig. 1 and 2), of which eight were nonspecific

FIGURE 2: Examination seven weeks post bronchogram (February 24, 1959) shows no trace of barium in the cysts or in their wall. Histologic examination proved that these "cavities" were bronchogenic cysts.

hbiting active infection has provided a tool with which to evaluate the presence of infection in residual annular pulmonary lesions. The "wall sign" results from phagocytosis of the barium sulfate from the bronchographic medium by the epithelioid cells or macrophages lining the cavity wall when inflammation and ulceration are present. Radiographically, this is apparent as a thin line of increased radiopacity outlining the wall of the cavity which persists for 24 or more hours after completion of the bronchogram.

FIGURE 3: Left sided barium bronchogram. PA, oblique and lateral views. The barium enters the cavities in the left upper lobe, more freely in one of them.
FIGURE 4: Four days later (October 21, 1963). There is coating of the wall of the cavities with barium particles (arrow) as compared with the pre-bronchographic examination (October 7, 1963), positive “wall sign.” The preoperative impression of nonspecific infection in bronchogenic cysts was substantiated following excision of the left upper lobe.

infections (abscess), (Fig. 3 and 4) and three were infected by tubercle bacilli (Fig. 4, 6 and 7); typical tuberculosis with cavity in 18; lung abscess in two; and

FIGURE 5: PA views of the chest on June 6, 1960, show extensive consolidation of the right upper lobe with multiple cavities. After ten months of treatment for tuberculosis (April 18, 1961) the consolidation has resolved, but several thin walled cavities remain in the right upper lobe.
cocidioidomycosis in one. The presence of tuberculosis was established pathologically in 21 patients, including the three patients found to have tuberculosis superimposed upon bronchogenic cysts.

In 11 patients, although the previously demonstrated cavity was filled with the barium suspension at bronchography, films taken 24 hours later failed to show a "wall sign." In six patients, these "cavities" were radiographically compatible with broncho-
genic cysts and three had this diagnosis established following resection of the lesion. Three patients were considered to have residual cavities of tuberculosis and of these, two had resection. One was found to have a very small active tuberculous cavity and the other an “open healed” tuberculous cavity without evidence of any infection in its fibrous wall. The third patient was not offered surgery in view of the conviction that this was an “open healed” cavity of tuberculosis. Two patients with small resi-

Figure 8: Left sided barium bronchogram shows no communication of the bronchi with the large tuberculous cavity in the left upper lobe.

Figure 9: PA views of the chest before and after the bronchogram show no difference in the appearance of the wall of the large cavity, although the small fluid level was eliminated. The diameter of the draining bronchus was too small for the passage of the viscous contrast medium although adequate for the drainage of the less viscous content of the cavity. The late film shows some residual contrast medium in the left lung from the previous bronchogram. Examination of the resected left upper lobe showed tuberculosilicosis with cavity.
dual defects following acute lung abscesses did not have positive "wall signs" and were not subjected to surgical therapy.

Of the 48 patients who had a cavitary lesion demonstrated in the prebronchographic films but had no filling of the cavity at the time of bronchography, the majority (37) were due to tuberculous cavities (Fig. 8 and 9). In 34 of these and one bronchogenic cyst infected with tuberculosis, the diagnosis was proved following resection. In only one of these cases was the cavity described as "open healed" by the pathologist. Infected bronchogenic cysts were found at the time of surgery in three patients, blebs in two, histoplasmosis in one, abscess in one and sporotrichosis in one. It is of incidental interest that one of the patients with a bronchogenic cyst had an unsuspected carcinoma in the wall of the cyst when this lesion was resected. Of two patients who refused surgery, the suspected diagnosis was bleb in one and histoplasmosis in the other.

**DISCUSSION**

The clinician, as he examines the chest film of a patient suspected or known to have tuberculosis, is often confronted with a thin-walled cavity and must decide whether this is a dangerous or benign lesion for that patient. While intrapulmonary blebs, bullae and bronchogenic cysts may have surgical implications, including the development of bronchogenic carcinoma in the latter, for the most part they can be dismissed from the present discussion if their true nature can be identified correctly.

The "open healed" tuberculosis cavity, if it truly represents the lesion described by Auerbach and Small, of a "cavity wall . . . transformed into a layer of connective tissue in which all signs of specificity have disappeared . . . with no tuberculous contents in the cavity wall" may well be of no greater consequence to the patient than any other annular defect within the lung.

The problem for the clinician is to differentiate the truly "open healed" lesion from the potentially active, partially "open healed" cavity or an active tuberculous cavity in the patient whose sputum does not contain tubercle bacilli.

It is suggested that the "wall sign" produced by the phagocytosis of barium sulfate in the infected cavity wall may be useful in differentiating these lesions. While a positive "wall sign" will not differentiate between a tuberculous cavity, an abscess, or the cavities of histoplasmosis or coccidioidomycosis, the presence of the positive sign may be interpreted as an indication for surgical resection providing other factors in the evaluation of the patient will allow the application of this therapy. The presence of barium in only a portion of the wall of a partially "open healed" tuberculous cavity at present is considered as an indication for resection, but might with additional evaluation and repeated barium bronchograms offer an opportunity to follow a partially "open healed" cavity progress to a completely healed cavity.

A negative wall sign may prove with further study to be a valid method of identifying "open healed" tuberculous cavities. While the present study does no more than hint that this may be true, all but one of the lesions with a negative wall sign were in all likelihood of no clinical importance to the patient and in that one exception, the pathologically proved typical tuberculous cavity was so small that it appeared well on its way to closing in the opinions of the surgeon and the pathologist who examined this specimen.

The fact that 48 of the 91 patients had no filling of the cavitary lesion is compatible with the bronchographic findings noted in most active tuberculous cavities and other infected defects of the lung and should not in any way detract from the potential importance of the positive "wall sign" as an indication for surgical therapy for the patient with a pulmonary cavity.

**SUMMARY**

1. Barium sulfate bronchograms were performed in 91 patients in an effort to
establish the characteristics of cavitary lesions demonstrated by other radiographic techniques.

(2) A positive "wall sign" indicating phagocytosis of the barium sulfate particles into the wall of the cavity was found in 32 of the 43 patients in whom the cavity was filled during bronchography.

(3) It is suggested that the presence of a positive "wall sign" is an indication of infection in the wall of the cavity and may have significance in differentiating between an active tuberculous cavity and an "open healed" cavity.

**References**


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