Flexible Fiberoptic Bronchoscopy in the Teaching Hospital*
Yield and Complications


We have prospectively analyzed the accuracy of and the rate of complications in 205 consecutive flexible fiberoptic bronchoscopic procedures, as performed in the setting of a teaching hospital. The objectives of the procedure were achieved in 89 percent of the cases, but the yield varied widely among 12 diagnostic and therapeutic subgroups. Except in the case of the peripheral nodule, a malignant neoplasm was correctly diagnosed or excluded with a sensitivity and specificity that were greater than 90 percent. Diffuse pulmonary infiltrates in both immunosuppressed and normal hosts were histologically diagnosed via the fiberoptic bronchoscope in 83 percent (25) of the 30 cases. Transfiberoptic bronchoscopic lavage resulted in reexpansion of lobar atelectasis in 84 percent (16) of the 19 patients with nonmalignant inflammatory disease, but in only 25 percent (one) of the four patients with malignant neoplasms. The overall rate of complications (11 percent) is higher than has been reported by others. Severe bronchospasm occurred in three of four asthmatic patients and led to the death of one, while pneumothorax followed transbronchial biopsy in two immunosuppressed patients receiving therapy with corticosteroids. The flexible fiberoptic bronchoscopic procedure represents an extremely reliable tool in the diagnosis and treatment of a wide variety of pulmonary disorders; the morbidity is significant but acceptable.

Since its introduction in 1968, the flexible fiberoptic bronchoscope has been refined, and its range of applications has been greatly expanded. Operators expert in the use of the fiberoptic bronchoscope, the biopsy forceps, and the bronchial brush report remarkable reliability and safety in many specific settings; however, the overall yield and rate of complications associated with the broad clinical use of flexible fiberoptic bronchoscopic procedures has not been prospectively studied.

In order to define the relative value of the flexible fiberoptic bronchoscopic procedure in various clinical situations, we have analyzed the diagnostic precision and the rate of complications for the procedure over a six-month period at the hospitals affiliated with the University of Colorado, Denver. We have determined the utility of the procedure in specific diagnostic and therapeutic settings, have identified specific subgroups of patients prone to complications, and have formulated recommendations based on these data.

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Materials and Methods

Patients and Personnel

Two hundred and five consecutive flexible fiberoptic bronchoscopic procedures were performed in 54 women and 151 men between 18 and 84 years of age. A serious underlying disease was present in 30 patients; ie, 12 had severe chronic obstruction of the airways (ratio of forced expiratory volume in one second over forced vital capacity was less than 40 percent), four had bronchial asthma, and 14 had severe immunosuppression (11 with leukemia or lymphoma and three with renal or hepatic transplants). Of the 12 with severe chronic obstruction of the airways, six had an arterial carbon dioxide tension greater than 45 mm Hg, and six had a value less than 45 mm Hg. No absolute contraindications precluded the flexible fiberoptic bronchoscopic procedures; bleeding diatheses revealed by an abnormal platelet count, prothrombin time, or partial thromboplastin time were corrected if possible with transfusions of platelets or with vitamin K supplements. Patients with acute or severe respiratory failure were intubated and mechanically ventilated.

The flexible fiberoptic bronchoscopic procedure was performed primarily by pulmonary fellows in training under the supervision of a physician from the pulmonary staff. Each fellow had performed approximately 35 procedures before the study began.

Procedure

A fiberoptic bronchoscope (Olympus BF-5B2 or BF-H2), biopsy forceps, and bronchial brush were utilized, and emergency medications and equipment for resuscitation were...
available on the bronchoscopic cart itself. The equipment was sterilized after each use by conventional techniques, but no attempt was made to maintain sterility during the procedure. The operator was not gowned or gloved and wore a protective mask only in those instances in which active pulmonary tuberculosis was suspected.

The procedure was performed in a specially equipped endoscopy or fluoroscopy suite. The procedure was performed at the bedside in 24 critically ill patients in whom there was need for respiratory support or intensive care monitoring. Precordication consisted of administration of atropine and codeine in 57 percent of the patients, with others receiving varying doses of diazepam, meperidine, and morphine. The fiberoptic bronchoscope was introduced by the direct nasotracheal approach (81 percent) or via an endotracheal tube (9 percent), nasopharyngeal airway (7 percent), or tracheostomy (3 percent), at the operator's discretion. The patient was in a supine or semirecumbent position in 97 percent of the instances; therapy with supplemental oxygen was administered in 154 patients (75 percent).

The operator was required to record his impression of the appearance of the tracheobronchial tree before a final diagnosis was known at the time of each procedure. In all cases in which a malignant neoplasm was suspected, histologic confirmation was required. A malignant neoplasm was considered to have been correctly excluded by normal findings from the flexible fiberoptic bronchosopic procedure only if the initial symptom or radiographic finding regressed or remained unchanged from 9 to 18 months following the procedure. Because of controversy as to the specificity of bacterial cultures obtained through the fiberoptic bronchoscope, the flexible fiberoptic bronchoscope was not used primarily for the collection of bacterial specimens, and a diagnosis of bacterial infection was considered substantiated only after appropriate clinical follow-up.

Results

Yield

The flexible fiberoptic bronchoscopic procedure yielded a definitive diagnosis or correctly excluded an alternative diagnosis in 89 percent of the instances in this study, with wide variations among various clinical subgroups.

Central Lesion. An intraluminal mass was visualized in 15 (50 percent) of the 30 patients who underwent a bronchoscopic procedure because of a radiographically visible central lesion in continuity with the hilum (Table 1); carcinoma was histologically confirmed in all by direct biopsy obtained at the time of the flexible fiberoptic bronchoscopic procedure. Extrinsic bronchial compression was seen in another 12 (27 percent) of the 30 patients, and a malignant neoplasm was present in all but one; however, in these patients, cytologic studies on the specimens from biopsy, brushing, and segmental lavage were uniformly unsuccessful. One of seven patients with completely normal findings on examination ultimately proved to have a mediastinal lymphoma.

Midzone Mass or Infiltrate Greater than 4 cm in

<table>
<thead>
<tr>
<th>Table 1—Flexible Fiberoptic Bronchoscopic Procedures in the Diagnosis of Malignant Central Lesions</th>
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<tr>
<td>Data</td>
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<td></td>
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<tr>
<td>No. of Patients</td>
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<tr>
<td>No. with malignant neoplasm</td>
</tr>
<tr>
<td>Diagnostic malignant histologic findings</td>
</tr>
<tr>
<td>at bronchoscopy</td>
</tr>
<tr>
<td>Malignant neoplasm diagnosed only by open</td>
</tr>
<tr>
<td>biopsy or autopsy</td>
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<tr>
<td>Malignant neoplasm excluded</td>
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*One patient lost to follow-up.
**Mediastinal lymphoma.
†See methods.

Diameter. Of 38 patients with a midzone mass or infiltrate (Table 2), the flexible fiberoptic bronchoscopic procedure established a specific histologic diagnosis in 20, and normal or inflammatory findings from the flexible fiberoptic bronchoscopic procedure correlated with an infectious etiology in 17 patients (see methods). An intraluminal mass was seen in all 11 patients who ultimately proved to have a malignant neoplasm, and abnormal findings on biopsy were obtained in ten of these. The patient with no histologic confirmation was known to have chronic lymphatic leukemia. Cytologic studies on the specimens from brushing and lavage demonstrated only abnormal lymphocytes, and an erroneous diagnosis...
of leukemic infiltration was made. Postmortem examination ultimately disclosed a squamous cell carcinoma.

A specific nonmalignant diagnosis was established at the time of the bronchoscopic procedure in nine patients (tuberculosis in two, sarcoidosis in one, usual interstitial pneumonitis in four, and bronchiectasis in two). One patient with adenocarcinoma that was metastatic to the lung underwent a nondiagnostic flexible fiberoptic bronchoscopic procedure; the diagnosis was made only at autopsy two weeks later. The remaining 17 patients in whom the findings from the bronchoscopic procedure were nondiagnostic have all had resolution of bacterial pneumonitis with antimicrobial therapy.

**Solitary Pulmonary Nodules.** Fifteen patients underwent flexible fiberoptic bronchoscopic procedures for evaluation of a solitary pulmonary nodule less than 4 cm in diameter. A malignant neoplasm was ultimately found in 11 patients. The diagnosis was established by transbronchial biopsy (Fig 1) or bronchial brushing (or both) in eight (73 percent) of these 11 patients, including all five of those with lesions greater than 2 cm in diameter. These procedures were not successful for diagnosis of the three patients with infectious granulomas.

**Multiple Nodules.** Only two patients with multiple pulmonary nodules underwent a flexible fiberoptic bronchoscopic procedure. In both cases, the findings from the procedure were normal, and autopsy revealed metastatic adenocarcinoma.

**Atelectasis.** Eighteen patients underwent a bronchoscopic procedure primarily for the diagnostic evaluation of atelectasis. In one patient with disseminated adenocarcinoma, the procedure was aborted because of laryngospasm. The remaining five patients with malignant neoplasms were correctly diagnosed by histologic material obtained at the time of the flexible fiberoptic bronchoscopic procedure, and in none of the 12 patients in whom the findings from the procedure were normal has a tumor subsequently been demonstrated. There were no false-positive or false-negative procedures.

Therapeutic transfiberoptic bronchoscopic lavage was performed in 23 patients with atelectasis, including 11 patients in whom this procedure was performed after diagnostic exploration. Lobar collapse resolved or improved within one hour of the flexible fiberoptic bronchoscopic procedure in 16 of 19 patients with a nonmalignant cause for the condition but in only one of four with a neoplasm.

**Abscess.** Four of seven patients who underwent the bronchoscopic procedure for evaluation of a pulmonary abscess had a cavitary squamous cell carcinoma, all of which were histologically diagnosed by the flexible fiberoptic bronchoscopic procedure. Intracavitary biopsies were performed when technically possible (Fig 2). Prolonged antimicro-

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**FIGURE 1.** Transbronchial lung biopsy of asymptomatic coin lesion. Pathologic sections demonstrated adenocarcinoma.

**FIGURE 2.** Intracavitary biopsy of slowly resolving "abscess," revealing poorly differentiated squamous cell carcinoma. More proximal extracavitary biopsies demonstrated only inflammatory reaction.
Bacterial therapy has resulted in radiographic healing in the three patients whose biopsies revealed only an inflammatory reaction.

Hemoptysis (No Discrete Radiographic Lesion). The final diagnoses established in 19 patients who underwent the bronchoscopic procedure because of hemoptysis are listed in the following tabulation:

<table>
<thead>
<tr>
<th>Localized bleeding</th>
<th>Diffuse bleeding</th>
</tr>
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<tbody>
<tr>
<td>Bronchogenic carcinoma</td>
<td>Hemorrhagic bronchitis</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>Tracheitis sicca (postsurgical)</td>
</tr>
<tr>
<td>Broncholith</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

(All three patients with an unknown cause for diffuse bleeding were diagnosed as having pneumonitis or bronchiolitis at the time of the flexible fiberoptic bronchoscopic procedure but were followed-up for less than nine months.) A malignant neoplasm was responsible for the hemoptysis in only two patients and was diagnosed by endobronchial biopsy in both instances; a specific site of bleeding was demonstrated in three patients with known diffuse pulmonary tuberculosis (Fig 3) as a guide to resectional therapy.

Diffuse Infiltrates in the Immunosuppressed Host. A specific diagnosis was established in five of ten immunosuppressed patients undergoing flexible fiberoptic bronchoscopic procedures because of diffuse pulmonary infiltrates (infection with Pneumocystis carinii in one, miliary candidiasis in one, cyclophosphamide-induced pulmonary disease in one, and lymphomatous infiltration in two). In addition, nonspecific inflammation with polymorphonuclear infiltration was seen in three patients and led to broad-spectrum antibacterial therapy; two patients responded, and one died. In the final two patients the flexible fiberoptic bronchoscopic procedure was aborted before biopsy because of dyspnea in one and because of an acute hysterical reaction in the other.

Diffuse Interstitial Pneumonitis. The flexible fiberoptic bronchoscopic procedure with transbronchial biopsy was diagnostic in 17 of the 20 patients with diffuse interstitial infiltrates. Usual interstitial pneumonia was the most common finding and was present in ten patients (50 percent of our cases). Other diagnoses included silicosis, pulmonary alveolar proteinosis, vasculitis, scleroderma, asbestosis, and viral pneumonitis.

The biopsy was not diagnostic in three patients. Two of these underwent open thoracotomy, and usual interstitial pneumonia was found in both. In the third patient the diagnosis remains unknown.

Endotracheal Intubation. Placement of an endotracheal tube via the fiberoptic bronchoscope was successful in all nine patients in whom such placement was attempted.

Cough or Wheeze. Inspection of the airway excluded endobronchial disease in all of the 20 patients with an unexplained cough or wheezing.

Repeat Bronchoscopic Procedure. An endobronchial mass was seen in five patients with a suspected malignant neoplasm in whom the material from biopsy did not demonstrate a neoplasm. At the repeat bronchoscopic procedure, histologic confirmation of a malignant neoplasm was obtained in four patients. In the fifth patient a second biopsy again showed only severe chronic bronchitis; this patient remains alive and well at 15 months of follow-up with no additional evidence of neoplastic disease.

Complications

Twenty-two complications (11 percent) occurred within 24 hours of the 205 bronchoscopic procedures in this series as shown in the following tabulation:

<table>
<thead>
<tr>
<th>Major complications</th>
<th>Minor complications</th>
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<tbody>
<tr>
<td>Bronchospasm or laryngospasm</td>
<td>Infiltrate without fever</td>
</tr>
<tr>
<td>(one death)</td>
<td>Fever</td>
</tr>
<tr>
<td>Pneumothorax requiring chest tube</td>
<td></td>
</tr>
<tr>
<td>Hemoptysis</td>
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Figure 3. Selective transfiberoptic bronchoscopic bronchogram in patient with massive hemoptysis and severe ventilatory compromise from diffuse far-advanced pulmonary tuberculosis. Blood had been seen emanating from lateral basal segmental bronchus of left lower lobe; bronchiectatic cavity demonstrated had not been apparent on plain chest x-ray film. Following wedge resection of this lesion, patient's pulmonary function returned to baseline values.
The presence of complications did not correlate with the type or amount of premedication or local anesthetic agent used.

Bronchospasm or laryngospasm (or both) complicated the flexible fiberoptic bronchoscopic procedure in only one of the 201 nonasthmatic patients but occurred in three of the four asthmatic patients in this study and resulted in the death of one. In all four patients, introduction of the bronchoscope was by the direct nasal-oral route, without intubation or use of a nasopharyngeal airway. All four patients were receiving aminophylline by continuous intravenous infusion, and suppression of coughing in all was achieved adequately with subcutaneous administration of atropine, intramuscular injection of codeine, and topical administration of lidocaine.

Pneumothorax requiring drainage via a thoracostomy tube occurred in two of seven immunosuppressed patients undergoing transbronchial biopsy for diffuse infiltrates; subcutaneous emphysema not requiring treatment followed the flexible fiberoptic bronchoscopic procedure in two of 99 otherwise normal patients undergoing the procedure.

Hemoptysis of greater than 40 ml within 15 minutes or 200 ml within 24 hours followed the flexible fiberoptic bronchoscopic procedure in four patients, including one thrombocytopenic patient in whom no biopsies had been done. One patient with severe chronic respiratory failure required therapy with assisted ventilation following aspiration of an estimated 100 ml of blood after biopsy of a friable squamous cell carcinoma of the trachea.

**Discussion**

An appreciation of the relative significance of both the normal and the abnormal findings on bronchoscopic examination is essential to the intelligent evaluation of the patient with suspected pulmonary neoplasm and should reflect the accuracy of the operator's visual impression, as well as the results of procedures for biopsy. These data are presented in Table 3. In this table, a positive procedure is considered one in which a cancer is either diagnosed histologically or suspected visually (or both), while a negative procedure is one resulting in no histologic or visual suggestion of neoplasm. By these criteria the sensitivity of the procedure for the diagnosis of carcinoma exceeded 90 percent in all categories except the peripheral nodule. Similarly, in all categories except the peripheral nodule, a completely negative flexible fiberoptic bronchoscopic procedure ruled out a malignant neoplasm with an accuracy of greater than 90 percent, the two exceptions occurring in patients with hematologic malignant disease.

The utility of transbronchial biopsy and brushing in diffuse pulmonary diseases has been noted by others and is confirmed in this study. In those cases in which the procedure was completed without complication, all immunosuppressed patients with diffuse infiltrates were accurately diagnosed, as were 85 percent (17) of 20 otherwise normal patients with diffuse disease. The correlation between transbronchial and open biopsy has been reported elsewhere.

The overall rate of complications in our study was 11 percent and included one death. This is significantly higher than has been reported by others and may be related to one of several factors. As the procedures reported herein were performed primarily by pulmonary fellows in training, it is possible that this rate reflects technical skills less developed than those of acknowledged experts, despite close supervision by experienced pulmonary physicians from the staff; however, it should be noted that in contrast with other series, this study was a prospective analysis of consecutive patients and that even those procedures terminated because of complications before introduction of the fiberoptic bronchoscope are included. Eight specific complications were explicitly sought for the 24 hours following every procedure; it is possible that some complica-
tions might have been overlooked in the retrospective analyses previously reported.\textsuperscript{13}

It is noteworthy that two of the three defined risk groups suffered a majority of the major complications in this study. Both serious pneumothoraces occurred in immunosuppressed patients receiving corticosteroids, and three of the four instances of bronchospasm or laryngospasm occurred in asthmatic patients, resulting in the death of one. The latter danger has been noted previously,\textsuperscript{14} although its incidence has not been defined. While it is possible that such episodes might be avoided by prior endotracheal intubation, as suggested by Zavala et al,\textsuperscript{15} others have specifically cautioned against this procedure in the asthmatic population.\textsuperscript{3} It is currently our practice to avoid bronchoscopic procedures in asthmatic patients unless strongly indicated and in those instances to undertake the procedure via an endotracheal tube following pretreatment with high doses of atropine, intravenous therapy with corticosteroids, and methylxanthines. We have not as yet performed enough procedures in this manner to be certain of its efficacy in averting bronchoscopic complications.

Pulmonary infiltrates developed immediately following transbronchial biopsy in four patients, presumably as a result of intraparenchymal hemorrhage, but infectious complications did not occur in our study. This is particularly pertinent, in that there was no attempt to maintain complete sterility during the procedure,\textsuperscript{8} and suggests that the instances of fever, sepsis, and pneumonia reported by others\textsuperscript{13,16,17} may be related to inadequate sterilization of equipment, rather than to asepsis of personnel.

The data presented in this report illustrate the spectrum of results and complications to be expected from the flexible fiberoptic bronchoscopic procedure in the teaching hospital. It is hoped that these data may serve as a basis for evaluating the role of the procedure in a wide range of specific clinical situations.

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REFERENCES

7 Ellis JH Jr: Transbronchial lung biopsy via the fiberoptic bronchoscope: Experience with 107 consecutive cases and comparison with bronchial brushing. Chest 68:524-532, 1975
12 Levin DC, Wicks AB, Ellis JH: Transbronchial lung biopsy via the fiberoptic bronchoscope. Am Rev Respir Dis 110:4-12, 1974