Current Status of Radiologically Directed Pulmonary Thin Needle Aspiration Biopsy

An Analysis of 200 Consecutive Biopsies and Review of the Literature

R. DUREN JOHNSON, M.D.,* ROLF P. GOBIEN, M.D.,† and JOSEPH F. VALICENTI, Jr., M.D.*

Departments of Pathology* and Radiology†
Medical University of South Carolina,
Charleston, SC 29425

ABSTRACT

The results of 200 consecutive pulmonary thin needle aspiration biopsies (TNAB) are presented. A diagnostic yield of 89.5 percent was obtained, with 5.5 percent of biopsies insufficient for diagnosis. There were six (3 percent) false negative biopsies and one (0.5 percent) false positive biopsy. The predictive value of positive result was 99.2 percent. The predictive value of a negative result was 90.8 percent. Cytologic examination correctly classified 72.1 percent of primary pulmonary carcinomas. The major complication was pneumothorax which occurred in 33.5 percent of TNAB. Techniques for improving the reliability of TNAB diagnosis are discussed, and pertinent literature is reviewed.

Introduction

In 1883, Leyden64 reported the first pulmonary needle biopsy from which he identified the bacterium responsible for a case of pneumonia. In 1886, Menetrier74 was able to establish a diagnosis of lung cancer from tissue obtained by needle aspiration. Several years later, Horder42 reported the procedure in Lancet. In the United States, Colby12 in 1909 described therapeutic lung puncture in the treatment of pneumonia. These authors and other early investigators employed large bore needles which were responsible for frequent and serious complications, and the procedure did not become a popular one.18

By 1930, Martin and Ellis69 had considerably refined the procedure and were able to obtain diagnostic tissue in 80 percent of cases. Their pulmonary aspirations were performed using stereo-roentgenograms for guidance. This report was followed by a series of publications firmly establishing the method’s value for the diagnosis of pulmonary lesions.15,16,68,108 Craver15 in 1940 described the important role that biplane fluoroscopy could play in needle aspiration. However, Ochsner and DeBakey83 condemned pulmonary aspiration biopsy on the grounds that it
was unsafe and led to implantation metastasis along the needle track. Their objections were not confirmed by Gledhill, Spriggs, and Binford who concluded that needle aspiration was a reliable and safe procedure. The development of image-intensifier television techniques and the wider availability of biplane fluoroscopy made reliable application of pulmonary needle aspiration a reality in the early 1960's. Over the next two decades, numerous reports and several books documented the increasing sophistication and utility of needle aspiration biopsy and cytology in the diagnosis of thoracic disease.

This paper presents the results of the first 200 consecutive thoracic thin needle aspiration biopsies (TNAB) performed at the Medical University of South Carolina between January 1980 and February 1982.

**Materials and Methods**

All patients in the present series were referred for TNAB of undiagnosed intrathoracic mass lesions. In most cases, other more conventional diagnostic techniques, such as sputum cytology, bronchoscopy, and scalene lymph node biopsy, had failed to establish a diagnosis. In a small number of cases, sputum cytology and bronchoscopy eventually yielded diagnostic results, but these were unknown and unavailable at the time of TNAB. Aspirations were attempted on all referred patients with a mass lesion visible by any imaging modality. No patient was refused TNAB for reasons of lesion size, location, or anticipated difficulty of the procedure. Contraindications to TNAB were considered in a relative sense. That is, if denial of TNAB would necessitate a more dangerous diagnostic procedure (thoracotomy), the procedure was attempted in spite of the risk.

Prior to the biopsy procedure, the patient’s chart and radiographs were reviewed by the cytopathologist and radiologist. If the lesion was easily seen in both frontal and lateral projections, no further imaging was performed. If the exact location of the lesion was indeterminate on one of the views, additional imaging studies including linear tomography or computer tomography (CT) were performed. The majority of patients were biopsied using biplane fluoroscopy as the guidance mechanism (figure 1) for a 22 gauge Chiba needle. Patients were biopsied from the anterior or posterior chest wall depending on the distance from skin to lesion (least distance chosen) and on the number of pleural surfaces between skin and lesion (fewer pleural surfaces desired). Biplane fluoroscopy allowed a high degree of assurance that the sample obtained did, in fact, come from the lesion. In a small percentage of patients the lesions were not fluoroscopically visible. These patients were biopsied using CT as the guidance mechanism, according to a published protocol. If an adequate sample was not obtained in spite of the fact that the needle was considered to be in the lesion, or if the needle would not enter a hard or scarred lesion, a Rotex screw needle was employed (figures 2 and 3). Smears of the aspirated material were made on frosted slides by the cytopathologist according to the technique of Zajicek (figure 4). The smears were immediately fixed in 95 percent ethanol. Generally six to eight smears could be prepared from a single aspiration. Whenever sufficient material was aspirated, two fixed smears and two unfixed, air dried smears were not immediately stained but set aside for special stains. The remaining fixed smears were stained using a modified Papanicolaou quick stain (table I). In cases of

---

* Tanaka Sansei Do, Inc., Tokyo, Japan. Cook, Inc., Bloomington, IN.
† (Ursus Konsult AB, Grev Turegatan, Stockholm, Sweden.)
suspected infection or repeat aspiration following a non diagnostic one, a general purpose transport medium‡ was inoculated with any remaining aspirate and transported immediately to the microbiology laboratory. During preparation and staining of the smears (approximately 15 minutes), the patient remained in the fluoroscopy suite where the procedure could be repeated if the sample proved inadequate. A post biopsy chest film was obtained on each patient before their return to the hospital floor. Follow-up chest films were obtained as clinically indicated. Outpatients were observed in the waiting area of the Radiology Department for four hours, had repeat chest X-ray, and were instructed about the symptoms of pneumothorax before being allowed to leave.

Results

Two hundred consecutive TNAB were obtained on 184 patients. Fourteen pa-

‡ (Port-A-Cul™, BBL, Div. of Becton-Dickinson and Co., Cockeysville, MD.)
patients had repeat aspirations and two patients had second aspirations for two separate lesions. Fourteen aspirations were performed on outpatients; no outpatient had a repeat aspiration. One-hundred eighty TNAB were obtained under biplane fluoroscopy. Nine TNAB were obtained under single plane fluoroscopy owing to equipment failure. This resulted in two specimens insufficient for diagnosis. Eleven aspirations were performed under CT guidance. Two of these specimens were insufficient for diagnosis. One CT guided TNAB was terminated due to a pneumothorax before an adequate sample could be obtained. One-hundred thirty-four patients (73 percent) were male with a mean age of 59 years. Fifty patients (27 percent) were female with a mean age of 55 years. The age range was 13 to 87 years. The lesions successfully aspirated ranged in size from 0.5 cm to 10 cm in diameter, with the majority measuring 2 to 4 cm. Overall diagnostic results for the series are listed in table II.

Primary Lung Carcinoma

Ninety-nine patients (74 males, mean age 61 years and 25 females, mean age 64 years) were proven to have primary lung carcinoma. A comparison of their TNAB results with sputum cytology and bronchial specimens appears in table III.
TABLE I

Modified Papanicolaou Quick Stain

<table>
<thead>
<tr>
<th>Step</th>
<th>Stain</th>
<th>Dips</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tap water*</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Tap water</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Gill’s hematoxylin</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>Tap water</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Tap water</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Scott’s tap water</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Tap water</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>Ethanol 50 percent</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>Ethanol 70 percent</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>Ethanol 95 percent</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>Ethanol 95 percent</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Gill’s eosin</td>
<td>30</td>
</tr>
<tr>
<td>13</td>
<td>Ethanol 95 percent</td>
<td>10</td>
</tr>
<tr>
<td>14</td>
<td>Ethanol 95 percent</td>
<td>10</td>
</tr>
<tr>
<td>15</td>
<td>Ethanol 95 percent</td>
<td>10</td>
</tr>
<tr>
<td>16</td>
<td>Ethanol 100 percent</td>
<td>10</td>
</tr>
<tr>
<td>17</td>
<td>Ethanol 100 percent</td>
<td>10</td>
</tr>
<tr>
<td>18</td>
<td>Xylol</td>
<td>10</td>
</tr>
<tr>
<td>19</td>
<td>Xylol</td>
<td>10</td>
</tr>
</tbody>
</table>

*In bloody specimens a few drops of glacial acetic acid may be added to lyse red blood cells.

One suspicious, one negative, and two insufficient TNAB were repeated; three of these were positive, while one repeat remained insufficient for diagnosis. One patient with TNAB insufficient for diagnosis and four patients with negative TNAB were surgically biopsied and proven to have carcinoma. The remaining suspicious TNAB occurred in a patient with superior vena cava syndrome. No additional effort was made to establish a tissue diagnosis in this case, and radiation therapy was given.

In table IV is compared the diagnostic yield of TNAB with that of sputum cytology and bronchoscopy specimens. An average of 3.5 negative sputa and 2.3 negative bronchial specimens were obtained from patients having these diagnostic studies. In addition, 30 lymph nodes (scalene or suprachlavicular) were removed from 28 patients. None was positive for carcinoma.

In table V are listed the cytologic diagnoses in the 92 positive TNAB. In 43 cases (46 percent), histologic confirmation became available. The correlation between cytologic and histologic diagnoses for 41 of these cases is presented in table VI. The adenocarcinoma interpreted as a small cell carcinoma was a poorly preserved specimen, and histologic confirmation was recommended. One small cell carcinoma was interpreted as a carcinoid. Histologic confirmation had been recommended in this case as well. One cytologically undifferentiated tumor (carcinoma, NOS) retained that diagnosis after tissue sections were examined. Therefore, 72.1 percent (31/43) malignant lesions were correctly classified by cytologic examination. Patients not having histologic confirmation of their cytologic diagnosis have all pursued a clinical course consistent with primary lung carcinoma.

Metastatic Cancer and Non-Pulmonary Thoracic Cancer

Thirty-one patients had either metastatic cancer or a non-pulmonary primary thoracic cancer. The results of TNAB in this group are listed in table VII.

Two insufficient TNAB were repeated with positive results. A third patient had repeat TNAB after the tumor, a lymphoma, recurred following chemotherapy; both TNAB were positive in this patient. Three TNAB insufficient for diagnosis were not repeated. One of these patients refused repeat TNAB but eventually consented to liver biopsy which resulted in a diagnosis of hepatocellular carcinoma. The second patient had an in-
TABLE III
Comparison of Thin Needle Aspiration Biopsy with Sputum Cytology and Bronchoscopy Specimens* in Patients with Proven Primary Lung Carcinoma

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Positive No. %</th>
<th>Suspicious No. %</th>
<th>Negative No. %</th>
<th>Insufficient No. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNAB</td>
<td>103</td>
<td>92 (89.3)</td>
<td>2 (1.9)</td>
<td>5 (4.9)</td>
</tr>
<tr>
<td>Sputum cytology</td>
<td>306</td>
<td>38 (12.4)</td>
<td>21 (6.7)</td>
<td>247 (80.7)</td>
</tr>
<tr>
<td>Bronchoscopy specimens</td>
<td>158</td>
<td>4 (2.5)</td>
<td>10 (6.3)</td>
<td>144 (91.1)</td>
</tr>
</tbody>
</table>

*Includes washings, brushings and/or biopsy.
FNA = figures not available.

TABLE IV
Comparison of Diagnostic Yield of Thin Needle Aspiration Biopsy with Sputum Cytology and Bronchoscopy Specimens* in Patients with Proven Primary Lung Carcinoma

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Patients</th>
<th>Positive No. %</th>
<th>Suspicious No. %</th>
<th>Negative No. %</th>
<th>Insufficient No. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNAB</td>
<td>99</td>
<td>92 (93)</td>
<td>1 (1)</td>
<td>4 (4)</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Sputum cytology</td>
<td>71</td>
<td>11 (15.5)</td>
<td>7 (9.9)</td>
<td>53 (74.6)</td>
<td>FNA</td>
</tr>
<tr>
<td>Bronchoscopy specimens</td>
<td>64</td>
<td>3 (4.7)</td>
<td>5 (7.8)</td>
<td>56 (87.5)</td>
<td>FNA</td>
</tr>
</tbody>
</table>

*Includes washings, brushings and/or biopsy.
FNA = figures not available.

sufficient TNAB owing to equipment failure (single plane fluoroscopy). This patient had stage IV mixed cellularity Hodgkin's disease at the time of TNAB; there has been no change in the pulmonary nodule over the past two years. The third patient with an insufficient TNAB diagnosis underwent thoracotomy which revealed both a thymoma and hilar lymphadenopathy consistent with sarcoi-

dosis. The single negative TNAB occurred in a patient with squamous cell carcinoma of the esophagus. The cytologic diagnosis for the 28 positive TNAB in this group are listed in table VIII.

FALSE POSITIVE DIAGNOSIS

A single false positive diagnosis was made in this series. A 58 year old male with a significant smoking history and cachexia underwent TNAB which yielded a specimen interpreted as adenocarcinoma. Pathologic examination of his lobectomy specimen disclosed pulmonary abscess secondary to actinomycosis. This patient has been followed for 18 months and has no evidence of any malignant lesion.

BENIGN LESIONS

Sixty-two TNAB were performed on 56 patients with benign lesions. These results appear in table IX.
TABLE VI
Correlation Between Cytologic and Histologic Diagnoses in 41 Cases

<table>
<thead>
<tr>
<th>Cytologic Diagnosis</th>
<th>Squamous Cell Carcinoma No. %</th>
<th>Adeno-Carcinoma No. %</th>
<th>Small Cell Carcinoma NOS* No. %</th>
<th>Large Cell Carcinoma No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squamous cell carcinoma</td>
<td>10 (76.9)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>2</td>
<td>15 (65.2)</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Small cell carcinoma</td>
<td></td>
<td>5 (83.3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*NOS = Not otherwise specified.

Two TNAB in this group represent second aspirations on patients with malignant disease. A patient previously diagnosed by TNAB as having metastatic renal cell carcinoma had a second TNAB of enlarged hilar lymph nodes consistent with granulomatous disease. The other patient had TNAB of two separate lesions: one adenocarcinoma and one fibro-collagenous tissue consistent with a scar. Both of these diagnoses were surgically confirmed.

The two patients with TNAB insufficient for diagnosis were repeated with diagnostic results. The patient with a suspicious TNAB was surgically biopsied and found to have healed granulomatous disease of indeterminate etiology.

Four of five TNAB in patients with benign tumors were surgically confirmed.

TABLE VII
Diagnostic Yield of Thin Needle Aspiration Biopsy in Metastatic Cancer and Non-Pulmonary Thoracic Cancer

<table>
<thead>
<tr>
<th>Specimens</th>
<th>Positive No. %</th>
<th>Suspicious No. %</th>
<th>Negative No. %</th>
<th>Insufficient No. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>28 (82.4)</td>
<td>0</td>
<td>1 (2.9)</td>
<td>5 (14.7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patients</th>
<th>Positive No. %</th>
<th>Suspicious No. %</th>
<th>Negative No. %</th>
<th>Insufficient No. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>27 (87.1)</td>
<td>0</td>
<td>1 (3.2)</td>
<td>3 (9.7)</td>
</tr>
</tbody>
</table>

One lipoma was not surgically resected. Of the 26 TNAB diagnostic of specific benign disease, one case of tuberculosis, three abscesses, one case of actinomycosis, and one pulmonary scar were confirmed with either culture of TNB material or surgical biopsy.

Twenty-eight TNAB showed non-specific inflammatory lesions. Of the 12 granulomatous lesions, four have been surgically biopsied: one hamartoma, one non-specific granuloma, one talc granuloma, and one actinomycosis. Of the 15

TABLE VIII
Cytologic Diagnoses in 28 Thin Needle Aspiration Biopsy for Metastatic Cancer and Non-Pulmonary Thoracic Cancer

<table>
<thead>
<tr>
<th>Cytologic Diagnosis</th>
<th>Site of Primary Tumor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squamous cell carcinoma - 8</td>
<td>Tongue/mouth, larynx, esophagus, cervix</td>
</tr>
<tr>
<td>Adenocarcinoma - 9</td>
<td>Endometrium, breast, kidney, prostate, colon</td>
</tr>
<tr>
<td>Myeloma - 2</td>
<td>Rib, Skin of back</td>
</tr>
<tr>
<td>Melanoma - 1</td>
<td>Arm, Small bowel</td>
</tr>
<tr>
<td>Malignant carcinoid - 1</td>
<td>Mediastinum</td>
</tr>
<tr>
<td>Liposarcoma - 1</td>
<td>Mediastinum</td>
</tr>
<tr>
<td>Lymphoma - 2*</td>
<td>Mediastinum</td>
</tr>
<tr>
<td>Thymoma - 1</td>
<td>Mediastinum</td>
</tr>
<tr>
<td>Hodgkin's disease - 1</td>
<td>Endometrium</td>
</tr>
<tr>
<td>Carcinosarcoma - 1</td>
<td>Vertebral column</td>
</tr>
<tr>
<td>Malignant neoplasm - 1 (chondrosarcoma)</td>
<td></td>
</tr>
</tbody>
</table>

*One patient with two positive TNAB.
mixed inflammatory lesions, seven have been surgically biopsied: three cases tuberculosis, three cases sarcoidosis, and one case actinomycosis. One patient with a mixed inflammatory exudate was re-aspirated and a diagnosis of histoplasmosis was made. One TNAB showed only necrotic debris, consistent with atheromatous material from an aortic aneurysm.

Patients not having independent confirmation of their benign diagnosis have been followed clinically and with serial chest X-rays for eight months to two and one-half years. All have shown either resolution of their lesion or no detectable clinical or radiologic change on follow-up examination.

Sensitivity, Specificity, and Predictive Value

Sensitivity, specificity, and predictive values were calculated according to standard methods. These results are listed in tables X and XI.

Complications

The overall incidence of pneumothorax was 33.5 percent. Twelve percent of TNAB resulted in pneumothorax with symptoms severe enough to require treatment, i.e., aspiration via catheter and/or insertion of a chest tube. Pneumothorax occurred more frequently when patients were biopsied through the anterior chest wall, 21.5 percent, as compared to 12 percent for a posterior approach.

Approximately, 20 percent of patients experienced transient hemoptysis (blood-

### Table IX

Cytologic Diagnoses in 62 Thin Needle Aspiration Biopsy of Benign Lesions

<table>
<thead>
<tr>
<th>Diagnoses</th>
<th>Number</th>
<th>Cases</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign Tumors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown tumor of bone - 1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronchogenic cyst - 1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lipoma - 2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benign mesothelioma - 1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific Benign Disease</td>
<td>26</td>
<td></td>
<td>41.9</td>
</tr>
<tr>
<td>Tuberculosis - 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Histoplasmosis - 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptococcosis - 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actinomycosis - 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abscess - 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibrocollagenous tissue (scar) - 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lipoid pneumonia - 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pseudotumor (loculated fluid) - 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-specific Inflammatory Lesions</td>
<td>20</td>
<td></td>
<td>45.2</td>
</tr>
<tr>
<td>Granuloma - 12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed inflammatory exudate - 15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Necrotic debris - 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspicious for Carcinoma</td>
<td>1</td>
<td></td>
<td>1.6</td>
</tr>
<tr>
<td>Insufficient for Diagnosis</td>
<td>2</td>
<td></td>
<td>3.2</td>
</tr>
</tbody>
</table>

### Table X

Sensitivity, Specificity, and Predictive Values* of Thin Needle Aspiration Biopsy in the Diagnosis of Malignant Disease

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Predictive value of a positive result</th>
<th>Predictive value of a negative result</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP % = 119 % = 96</td>
<td>TN % = 55 % = 98.2</td>
<td>TP % = 119 % = 99.2</td>
<td>TN % = 55 % = 91.7</td>
</tr>
</tbody>
</table>

*TP = true positive; FP = false positive.
TN = true negative; FN = false negative.
streaked sputum only) shortly after TNAB while still in the fluoroscopy suite. Two patients had persistent hemoptysis noted in their hospital charts. Neither patient required treatment. Three patients developed pleural hematomas at the TNAB site. One patient developed seizures during TNAB, and one patient experienced a syncopal episode following TNAB. No evidence of implantation metastasis in the needle track has been documented in this series.

Discussion

Over the past 20 years, thin-needle aspiration biopsy has become an accepted minimally invasive diagnostic procedure. Even so, some physicians continue to express concern over its safety and diagnostic effectiveness. The primary purpose of TNAB is to establish or to rule out a malignant process. When properly performed by an experienced interventional radiologist and evaluated by a competent cytopathologist, TNAB is reported to have a sensitivity of 73.9 percent to 99 percent and a specificity of 87 percent to 100 percent. These authors also report predictive values of a positive result of 99.28 percent to 100 percent, and predictive values of a negative result of 52.87 percent to 72 percent. A high predictive value of a positive result is extremely important in "ruling in" malignant disease, since it allows confident institution of early and appropriate surgical, chemical, or radiation therapy. A high predictive value of a negative result in "ruling out" malignant disease would be just as important since it could avoid a costly and possibly dangerous further work-up for malignant disease. It is the feeling of the present authors that our predictive value of a negative result exceeded those of previously published reports for several reasons:

1. Prior to the aspiration procedure, a thorough effort is made to determine the precise location of the lesion and the most advantageous approach for biopsy. This helps to insure adequate and representative specimens from the lesion and has resulted in only 5.5 percent of our TNAB inadequate or unsuitable for diagnosis, as compared with the 18 percent to 22 percent reported by others.

2. Smears are immediately stained and evaluated by the cytopathologist. If the first specimen is inadequate, immediate re-aspiration may be performed. In lesions composed largely of hard or dense tissue, e.g., scars, hamartomas, granulomas, the use of a Rotex screw needle usually provides sufficient tissue for diagnosis.

3. A differential diagnosis is formulated before proceeding with the aspiration. This process allows us to anticipate the need for special stains or cultures. Aspirations yielding poorly differentiated malignant cells were also stained with mucicarmine, periodic acid-Schiff (PAS) or alcian blue. Thin needle aspiration biopsy negative for malignancy were subjected to a further work-up in an effort to establish a specific diagnosis. This was done according to a published protocol designed to enhance the specificity and acceptability of negative aspirates.

Special stains often help to delineate the precise nature of a neoplasm in a TNAB specimen. Electron microscopy has also been used to classify malignant cells obtained by TNAB. A wide variety of neoplasms have now been described in TNAB specimens including lipoma, hamartoma, fibrous histiocytoma, mucopidermoid carcinoma, broncho-alveolar carcinoma, neural tumors, pheochromocytoma, and hemangiosarcoma. The judicious use of special stains and cultures on negative as-
pirates has permitted the diagnosis by TNAB of Legionnaire's disease, pneumocystis carinii, actinomycosis, aspergillosis, cryptococcosis, tuberculosis, and histoplasmosis. Energy dispersive X-ray analysis of TNAB material has also been used to confirm the diagnosis of pulmonary silicatosis.

False positive diagnoses occur in 1.5 percent to 4 percent of TNAB. Our single false positive diagnosis occurred in a patient with pulmonary actinomycosis. A similar case has been described by Poe and Tobin. The danger of a false positive diagnosis in the presence of an inflammatory or reparative process or in previously irradiated tissues has been pointed out by others, as the classical cytologic criteria of malignancy are not always applicable in aspiration cytology.

The accuracy of cytologic tumor classification in TNAB varies from 63.9 percent to 82.4 percent. Such low figures are at least partially explained by the difficulty in distinguishing between large cell undifferentiated tumors, poorly differentiated squamous cell carcinoma and poorly differentiated adenocarcinoma. In contrast, small cell carcinoma may be diagnosed with an accuracy of 90 percent in TNAB. This figure may improve with the application of specific staining techniques for small cell carcinomas.

Few studies are available on the reproducibility of cytologic diagnoses by TNAB. Francis and Hojgaard found a high degree of both intraobserver and interobserver correlation in the diagnosis of malignancy and in the classification of a particular cell type. Taft, Szyfelbein, and Greene found intraobserver agreement in regard to malignant cell types of 83 percent. Comparison studies of TNAB with sputum cytology and bronchoscopic biopsy have generally shown TNAB to be superior in the diagnosis of localized pulmonary lesions. This is particularly true for peripherally situated tumors and Pancoast tumors. However, open biopsy or fiberoptic bronchoscopy remain superior to TNAB in the diagnosis of diffuse parenchymal pulmonary disease. It is our feeling that patients with localized mass lesions who are not diagnosed within a short period of time by either sputum cytology or bronchoscopy will most likely not have a definitive diagnosis made by these methods.

The most frequently occurring complication of TNAB is pneumothorax. Sinner found the average rate to be 27.2 percent in a survey of 2,726 TNAB. Herman and Hessel reported an incidence of 23.1 percent in a review of 1,562 patients. An incidence as high as 57 percent has been reported. A number of factors appear to increase the incidence of pneumothorax including advanced age, larger lesion size, greater lesion depth, larger needle diameter, presence of severe emphysema, and inexperience of the operator. Our overall series incidence 33.5 percent (with 12 percent requiring chest tube or aspiration) is in line with these published values. The present authors feel that our incidence of pneumothorax could be lowered if all TNAB were performed by the single interventional radiologist (R.P.G.). However, the presence of a radiology residency program does not make this solution a feasible one. Techniques to prevent pneumothorax include breathing 100 percent oxygen by the patient or use of
a “lung patch” produced from the patient’s blood. We have not had experience with these methods. Unrecognized tension pneumothorax has been responsible for at least one death.

The incidence of other complications in our series was quite low. Minor hemoptysis has been reported to occur in 2 to 10 percent of patients. Significant hemorrhage leading to death of the patient is rare and only a few reports exist. Most of these deaths occurred following use of large bore (18 gauge or larger) cutting needles designed for core tissue biopsy rather than aspiration techniques. Six instances of fatal air embolism have been noted. However, Sinner was unable to document any deaths secondary to TNAB in his review of 2,726 cases. Herman and Hessel noted a mortality of 0.1 percent in aspiration biopsy as compared to 0.3 percent with core biopsy and 2.9 percent with trephine biopsy.

Other complications occurring with TNAB include local bleeding, mediastinal and subcutaneous emphysema, hemothorax, seizures, fever, and pleurisy. The problem of implantation metastasis along the needle track has received much attention in the literature. Earlier reports of this complication occurred in series of patients biopsied with large bore cutting needles designed for core tissue biopsy. Two additional reported cases have been refuted by Naylor. At present, three cases of implantation metastasis have been described as occurring after TNAB. It is of note that two of these cases occurred following TNAB of pancreatic carcinoma. Experimental studies have shown that malignant cells are often carried along the needle track of aspiration biopsies, but that such carriage lacks any significant biologic implication. Clinical studies have confirmed this conclusion when survival rates for patients undergoing aspiration biopsy are compared with controls. Baker points out that the risk of implantation metastasis with TNAB is lower than the operative mortality of exploratory thoracotomy. Lalli notes that cutaneous implantation of pulmonary neoplasms has been well documented in thoracotomies performed for the diagnosis and treatment of bronchogenic carcinoma. The theoretical threat of implantation metastasis would hardly seem to be a contraindication to the performance of TNAB.

Acknowledgments

The authors wish to express their gratitude to Barbara S. Gobien and Catherine Daniell for assistance with the aspirations and Leah Summers for typing the manuscript.

References


85. PERCY, J. N. and PATR, N. L.: Fatal pulmonary hemorrhage after percutaneous aspiration lung


