Fine-Needle Aspiration Biopsy of Mediastinal Masses: Evaluation of 136 Experiences

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Experience with 136 fine-needle aspiration biopsies of mediastinal masses performed in 84 patients is reviewed. Biopsies were performed in all compartments of the mediastinum regardless of age. The biopsy technique included a 22-gauge needle with limitation of needle passes to an arbitrary number of three. The biopsy procedure was guided by either fluoroscopy or computed tomography (CT); guidance by CT is advantageous in the region of the thoracic inlet, hilum, and middle mediastinum, in small mediastinal masses, and in patients with superior vena cava syndrome. In 67 patients (79.7%) a specific cytologic diagnosis was obtained; in seven patients (8.3%), despite the presence of cells in the cytologic specimen, diagnosis could not be assessed. In the other 10 patients (11%), the samples obtained did not contain any cells. Morbidity was low: Light complications occurred in 15 patients (16.6%); drainage of pneumothorax was necessary in only three more. Bronchoscopy provided histology in three patients out of 12, mediastinoscopy established histologic diagnosis in 10 patients out of 16; surgery to remove the mass was performed in 38 patients. It is believed that fine-needle aspiration biopsy should be the first invasive procedure in the workup for diagnosing the nature of a mediastinal mass.

In 1978 we published our first results with fine-needle aspiration biopsy of mediastinal masses in 18 patients [1]. Since then we have continued to perform these biopsies in all the compartments of the mediastinum [2–4] and for evaluation of superior vena cava syndrome [5]. This report summarizes and evaluates our further experience which now comprises 136 procedures in 84 patients.

Materials and Methods

In patients with a mediastinal mass, radiography, fluoroscopy, tomography, and lately computed tomography are the radiologic methods for establishing the size, site, and morphology of the lesion before fine-needle aspiration biopsy can be performed. The patient must give his consent for the procedure. We use two methods in planning and guiding our aspiration biopsies:

First, posteroanterior and lateral chest radiography and eventually tomography are used to determine the position and the depth of the lesion. The shortest and most direct skin-target distance is calculated. Accordingly the patient is placed on the one-directional, television-monitored fluoroscopy table, in supine or prone position. The projection of the lesion on the skin is marked and draped in a sterile fashion. A short, bevelled, sharp, 22-gauge, 15-cm-long needle is introduced vertically toward the lesion, preferably along the upper border of the ribs, during suspended respiration. Local anesthesia is used only in very apprehensive patients, general light anesthesia in infants and small children. The needle is advanced to the calculated depth, at which point a change in tissue resistance often can be felt. Short fluoroscopic control can monitor the direction of the needle toward the mass. When the site of the mass to be biopsied is reached, a 20-ml syringe is attached to the needle. By withdrawing the piston, negative pressure is created. The needle tip within the mass is gently rocked up and down three or four times along a vertical path of 0.5–1 cm inside the mass. Then the piston is returned to release the negative pressure, and in this position the needle and the syringe are removed.

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The contents of the needle are immediately ejected onto clean glass slides prepared by the cytology technician, who is present during the procedure. The cell material is smeared out as evenly and thinly as possible by the technician and immersed in 96% ethyl alcohol for fixation. The slides are subsequently stained and interpreted in the cytology department. If the slide does not seem to contain cell material, or the needle tip has been placed too centrally or too peripherally, the procedure can be repeated a second or even a third time, or else it can be postposed to another day. Before the patient is sent back to the ward, an expiratory chest film is performed to check whether a pneumothorax has occurred. After the examination, our routine consists of confining the patient to bed until a delayed expiratory chest film has been performed the next morning. The examination is never performed on an ambulatory basis.

For the second type of procedure, computed tomography is used to assess the optimal site of the puncture, which is indicated by a metallic marker on the skin; depth determination is then calculated by the aid of a grid or cursors projected over the image. The puncture is performed on the CT table by the same technique used for fluoroscopy in supine, prone, or decubitus position. When the needle tip reaches the calculated depth, a repeat scan monitors its position. After removal of the needle, occurrence of pneumothorax can be checked by a control scan. In certain cases, the CT images were used for planning alone, that is, determining the site of the puncture and the skin-target distance, but the biopsy itself was performed by fluoroscopy guidance.

In a number of patients, mostly in whom the fine-needle aspiration biopsy did not give results, bronchoscopy, mediastinoscopy, or anterior mediastinotomy were added to obtain histologic proof on the nature of the mediastinal mass. These procedures were performed under general anesthesia in the operating theater by the chest surgeon. Table 1 summarizes the methods used to obtain a cytologic or histologic diagnosis in 84 patients with mediastinal masses.

Our case material comprises 84 patients with mediastinal tumors in all the compartments of the mediastinum. Age and gender distribution are summarized in table 2. To obtain cytologic diagnosis by fine-needle aspiration biopsy, 136 punctures were performed in these 84 patients. Of these 84, 12 patients had bronchoscopy, 16 had mediastinoscopy or anterior mediastinotomy, and 38 had thoracotomy to obtain a diagnosis or to remove the tumor whenever feasible.

TABLE 1: **Methods Used in 84 Patients with Mediastinal Masses to Obtain Cytology or Histology**

Methods	Mediastinal Compartment			Total
	Anterior	Middle	Posterior	
Fine-needle aspiration biopsy:				
Fluoroscopy	28	6	3	37
CT	24	12	5	41
CT and fluoroscopy	6	0	0	6
Bronchoscopy	10	2	0	12
Mediastinoscopy	14	2	0	16
Surgery	32	2	4	38

TABLE 2: **Age and Gender Distribution of 84 Patients with Mediastinal Masses who Underwent Fine-Needle Aspiration Biopsy**

Age (years) and Gender	Mediastinal Compartment			Total
	Anterior	Middle	Posterior	
0–10	2	1	1	4
11–30	15	1	1	17
31–50	16	2	2	20
51–70	12	10	3	25
71+	13	4	1	18
Total	58	18	8	84
Male	36	10	7	53
Female	22	8	1	31

TABLE 3: **Success Rate and Complications of Fine-Needle Aspiration Biopsies in 84 Patients**

Success Rate and Complications	Mediastinal Compartment			Total
	Anterior	Middle	Posterior	
Cytologic diagnosis:				
Total	58	18	8	84
Specific samples	46	14	7	67
Unspecific samples	7	0	0	7
Unrepresentative samples	5	4	1	10
Complications:				
Hemoptysis	0	2	0	2
Pneumothorax	10	3	0	13
Drain	1	2	0	3

Results

Table 3 summarizes the success rate and complications of the fine-needle aspiration biopsies. Table 4 elaborates the complications in detail. Table 5 shows the results of bronchoscopy, mediastinoscopy, and thoracotomy in those patients in whom these procedures were performed. In analyzing the results of the fine-needle aspiration biopsies in our patient material, they were divided into two aspects, according to: (1) puncture site (anterior, middle, or posterior mediastinal masses); and (2) cytologic results (cytologically specific, unspecific, or unrepresentative samples) (tables 6 and 7).

Of the 84 patients, 58 had masses in the anterior mediastinum, and fine-needle aspiration biopsy resulted in a specific cytologic diagnosis in 46. This was confirmed by other invasive nonradiologic methods. In the other 12 patients with masses in the anterior mediastinum, the results of the fine-needle aspiration biopsies were grouped in two categories: In seven, even though the cytologic smear contained cells, the diagnosis could not be assessed. Subsequent mediastinoscopy and surgery established the diagnosis of thymoma in five and lymphoma in two. In the second group (five patients), the cytologic samples did not contain any cells, despite the hard resistance felt when the needle was advanced into the mass and despite visualization of the needle tip inside the mass. Four had large, bilateral, polycyclic masses and proved to have the nodular sclerotic form of Hodgkin disease [6].

Eighteen patients had hilar or middle mediastinal masses. In 14 of them, fine-needle biopsy established the diagnosis; nine presented clinically with superior vena cava syndrome. The smallest number of patients (eight) had masses in the posterior mediastinum; in all but one, fine-needle aspiration biopsy facilitated assessment of diagnosis.

The total number of complications was small (18 cases) and their nature innocuous (table 3). In two patients light hemoptysis occurred: one was aged 60 and the other 62, both with masses in the middle mediastinum; the number of

TABLE 4: **Complications of Aspiration Biopsy of Mediastinal Masses by Age, Number of Punctures, and Location in 18 Patients**

Complication/Age (years)	No. Punctures	Mediastinal Compartment
Hemoptysis:		
60	3	Middle
62	2	Middle
Pneumothorax drainage:		
18	1	Middle
19	2	Middle
28	2	Anterior
Pneumothorax:		
36	1	Anterior
40	2	Anterior
42	2	Anterior
44	2	Anterior
48	1	Anterior
53	1	Middle
53	3	Anterior
53	1	Anterior
62	2	Anterior
65	1	Anterior
65	1	Middle
69	2	Middle
75	1	Anterior

TABLE 5: **Success Rate of Bronchoscopy, Mediastinoscopy, and Surgery in 84 Patients with Mediastinal Masses**

Method	Mediastinal Compartment			Total
	Anterior	Middle	Posterior	
Bronchoscopy:				
Total	10	2	0	12
Successful	2	1	0	3
Mediastinoscopy:				
Total	14	2	0	16
Successful	9	1	0	10
Thoracotomy:				
Total	32	2	4	38
Successful	32	2	4	38

TABLE 6: **Cytologic Diagnosis from Aspiration Biopsy Confirmed by Other Procedures**

Diagnosis	Total	Cytology	Surgery (Surgical Biopsy); Bronchoscopy; Mediastinoscopy
Metastasis	41	39	4; 2; 4
Lymphoma, Hodgkin	18	11	9 (2)
Thymoma (malignant)	9	4	4
Teratoma, dermoid	5	5	5
Malignant cells	1	1	1
Myeloma	1	1	
Neurogenic tumor	2	2	2
Mesothelioma	1	1	1
Fibrosing mediastinitis	1	1	1
Inflammatory cells	2	2	2
Diagnosis deferred	3	0	

punctures performed was two and three, respectively. Sixteen patients had pneumothorax, but only in three was it necessary to introduce a chest tube. All three patients were aged 11-30 years. One had a mass in the anterior mediastinum and two punctures were performed. In the other two, the mass was in the middle mediastinum. The massive pneumothorax occurred in one patient after one puncture and in the second patient after two punctures. In the remaining 13 patients, five were aged 31-50 years, seven were 51-70, and one was 25.

TABLE 7: **Final Diagnosis in 14 Patients with Unspecific or Unrepresentative Aspiration Biopsy Samples**

Procedure	Final Diagnosis		
	Thymoma	Lymphoma (Hodgkin)	Metastasis
Cytology:			
Unspecific sample	5	2	0
Unrepresentative sample	0	5	2
Bronchoscopy	0	0	1
Mediastinoscopy	0	5	1
Surgery	5	7	0

In the age group of 31-50 years, all masses were in the anterior mediastinum, and pneumothorax occurred after one puncture in two patients and after two punctures in the other three. Of the seven patients aged 51-70, in three the mass was in the middle mediastinum, and pneumothorax occurred after only one puncture in two of them. In the remaining four patients with anterior mediastinal masses, pneumothorax could be detected after three punctures in one, after two punctures in two, and after one puncture in one patient. The oldest patient (aged 75) with an anterior mediastinal mass developed pneumothorax after one puncture. No direct correlation could be found among complication, age, and number of punctures.

Discussion

Modern medical therapy requires and expects precise and specific diagnosis on the nature of a mass, and this holds true for mediastinal tumors. Surgical methods like mediastinoscopy, anterior mediastinotomy, bronchoscopy, or even thoracotomy are necessary for obtaining histology. These invasive procedures require anesthesia and an operating theater. With the exception of thoracotomy, they are limited to the anterior or middle mediastinum.

As early as 1967, Nordenström introduced a radiologic approach to the anterior [7] and posterior [8] mediastinum. His methods are based on a technique similar to that used in angiography, using a cannula, guide wire, and catheter and they enable the performance of biopsy for histology or the injection of contrast material.

The development of cytology made aspiration biopsy by a fine needle feasible, and this technique has become universally accepted for different organs of the body [6, 9-12] for obtaining cell specimens. In 1978, we started using fine-needle aspiration biopsies guided by one-directional television-monitored fluoroscopy for evaluation of mediastinal masses. Patients in whom aneurysm has been excluded by radiography, fluoroscopy, contrast-enhanced computed tomography, or angiography are eligible for fine-needle aspiration biopsy.

The protocol of the aspiration technique has remained unchanged [1]: The 22-gauge, short, bevelled needle is used. It was arbitrarily decided to limit the number of punctures to three. We believe that the small number of complications may relate to this protocol. One-directional, television-monitored, fluoroscopy-guided fine-needle aspiration biopsy gives good results in anteriorly or posteriorly situated mediastinal masses.

Since computed tomographic equipment became available, we have begun to use it to guide our fine-needle aspiration biopsy procedures. It permits visualization of the mediastinum free from superimposition by other structures of the chest; also it allows a better selection of the puncture site and makes depth calculation very accurate. The advantage of visualizing the relation of the needle tip to the target by an additional scan during the procedure reinforces the confidence of the radiologist performing the biopsy. The scan at the end of the procedure to check the occurrence of a pneumothorax does not cause any discomfort to the patient. The whole procedure is carried out in the light, thus reducing the patient's apprehension. No radiation is conveyed to the radiologist. We now prefer to guide our fine-needle aspiration biopsies for mediastinal masses by CT in the following circumstances:

1. Masses in or near the thoracic inlet: The choice for the appropriate puncture site is easier with CT in view of the narrow bony cage of this region and the vicinity of the great vessels.
2. Hilar and middle mediastinal masses: Their relation to the pulmonary arteries and veins is best displayed by the transverse plane of the CT image; it facilitates the decision to puncture these deeply situated structures from an anterior, posterior, or axillary approach.
3. Patients with superior vena cava syndrome.
4. Small mediastinal masses only slightly distorting the mediastinal contour: Precise estimation of the site of the lesion and its distance from the skin is much more reliable with CT than that of radiography or fluoroscopy; bony structures lying in the path of the needle can be better evaluated and avoided.

A breakdown of the nature of the mediastinal masses in our patients showed that 41 of the 84 had metastases; in 39 of them, not only could the diagnosis be made by the aspiration biopsy, but cytology also identified the type of cells, an important consideration in today's aggressive and specific oncologic treatment. In addition, in four of these patients bronchoscopy or mediastinoscopy and surgery were done, which all confirmed the diagnosis and cell type of the cytologic specimen as obtained by the aspiration biopsy.

The next largest group by number of cases was 27 patients, 18 with lymphoma or Hodgkin disease and nine with thymoma. All the cases had surgical verification. We divided them into three categories: (1) 15 patients for whom the results of biopsy permitted a specific diagnosis; (2) seven patients for whom, although the samples contained cells, definite cytologic diagnosis as to the nature of the cells could not be made (unspecific sample); and (3) five patients for whom the samples contained no cells, only blood (unrepresentative sample). Four of those five had the nodular sclerotic type of Hodgkin disease.

The results in the 12 patients who had unspecific and unrepresentative samples possibly indicate a certain limitation in cytology; a similar experience has been described in lymph-node biopsies by the fine-needle aspiration technique [6]. We believe that an increase in the number of punctures would not overcome this problem.

Fine-needle aspiration biopsy of mediastinal masses is a relatively safe and easily tolerated procedure; when successful, it significantly reduces medical care costs, because it reduces the number of inpatient days and eliminates investigative surgical procedures, which necessitate anesthesia and operating theater. Despite certain limitations of cytology in groups of tumors in the anterior mediastinum, the overall results are rewarding: in 67 patients a diagnosis could be obtained. A negative result causes only a short delay in patient investigation at the cost of a relatively minor intervention for the patient, as compared to the alternative diagnostic procedures.

In view of these considerations, fine-needle aspiration biopsy should be the first invasive procedure in the workup of patients with mediastinal masses; information on the nature of the mass is obtained regardless of age, size, or mediastinal compartment. This holds even more true in patients with superior vena cava syndrome.

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