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Mediastinum & Esophagus: Short Report

Safety and Efficacy of Transsternal Core Biopsy of Anterior Mediastinal Masses

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ABSTRACT

BACKGROUND The study evaluated the safety and adequacy of percutaneous transsternal anterior mediastinal core biopsy.

METHODS All percutaneous computed tomography–guided transsternal mediastinal 18-gauge core biopsies performed at 2 academic centers were retrospectively reviewed. Procedural, clinical, and pathology data were recorded.

RESULTS Sixteen patients underwent biopsies. Nine had preexisting cancer diagnoses. Biopsy was performed with general anesthesia (3), monitored anesthesia care (7), and moderate sedation (6). All patients were discharged the same day, except 1 patient, in whom a pneumothorax developed, necessitating chest tube placement. Of 16 biopsies, 15 (94%) yielded pathologic diagnoses, including thymoma (4), benign lesion (3), and 8 malignant neoplasms (3 lung cancer, 3 lymphoma, 1 thymic carcinoid tumor, 1 sarcoma). In most (14/16), ≥3 core specimens were obtained. In the nondiagnostic biopsy, only 1 core was obtained. Tissue was adequate in 4 of 6 cases for ancillary testing. Eight patients received diagnoses from core biopsy indicating observation or medical therapy, obviating the need for an operation.

CONCLUSIONS Outpatient transsternal anterior mediastinal 18-gauge core biopsy is feasible, safe, and effective and may prevent unnecessary operations. Obtaining ≥3 cores may optimize diagnostic yield.

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Anterior mediastinal masses occur in 1% of people and include thymic tissue/neoplasms, thyroid and parathyroid masses, germ cell tumors, lymphoma, and carcinoma.[1] Tissue diagnosis determines management. Percutaneous core biopsy may be sufficient to render a diagnosis without requiring an operation. On occasion, lesions are retrosternal, rendering percutaneous biopsy challenging. Prior studies used smaller gauge needles and fine-needle aspiration to access retrosternal sites with transsternal approaches.[2] However, current oncology practices involve ancillary tests requiring core specimens. This series evaluates the safety and efficacy of percutaneous transsternal core biopsy with computed tomography (CT) guidance.

IN SHORT

- Transsternal mediastinal core biopsy yields diagnostic material in most cases with low procedural risk.
- Image-guided transsternal mediastinal biopsy can be performed with sedation on an outpatient basis and obviate the need for an invasive surgical procedure.

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PATIENTS AND METHODS

For this retrospective institutional review board-approved study, all patients who underwent CT-guided transsternal anterior mediastinal biopsy were identified (March 2017–June 2023) at 2 academic centers. Images, operative reports, sedation records, and charts were reviewed for technical and anatomic details, indications, pathologic results, and clinical outcomes. Procedure time was calculated as the total time of sedation.

Transsternal biopsy was performed with CT guidance in the supine position (Figure 1; Supplemental Figure 1) by 7 board-certified interventional radiologists with 3 to 30 years of experience. First, a coaxial bone guiding needle was advanced through the sternum, employing 11-gauge Arrow OnControl (Teleflex), 13-gauge Madison (Merit Medical), or 14-gauge Bonopty (AprioMed) systems. For 8 cases, approximately 1 mL of sterile gel was injected into the coaxial needle after removal of the inner cannula. Core biopsy specimens were then obtained with an 18-gauge side-notch spring-loaded needle, using either Bard Mission (Bard Medical) or Temno (Merit Medical) systems. Rapid on-site evaluation of touch preparations was performed for all cases. Patients were discharged after 1- to 2-hour post-biopsy chest radiographs on recovery from sedation.

FIGURE 1 Transsternal core biopsy technique. An 11–gauge coaxial bone biopsy needle (arrow) is advanced through the sternum to accommodate an 18–gauge core biopsy needle (arrowhead) through the 19–gauge coaxial guiding needle (asterisk). The needle trough is positioned in the lesion.

RESULTS

Each of 16 patients, including 8 men and 8 women with a mean age of 59 (range, 39-78) years, underwent 1 CT-guided transsternal biopsy (Table). Nine had prior cancer diagnoses (3 breast cancer, 3 Hodgkin lymphoma, 2 non-small cell lung cancer, 1 thyroid cancer). The procedure was performed under general anesthesia (3 cases), monitored anesthesia care (7 cases), or fentanyl and midazolam moderate sedation (6 cases). Mean procedure duration was 71 (range, 40-138) minutes. Mean radiation patient dose was 1518 (range, 148-5234) dose-length product. In all but 2 cases, $\geq$3 cores were obtained.

Of 16 biopsies, 15 (94%) yielded pathologic diagnoses. The nondiagnostic biopsy involved obtaining 1 core only. In 5 cases, thymic tissue was obtained, with 4 demonstrating thymoma. In 2 thymoma cases, surgical resection was not performed because 1 patient refused and the other had metastatic carcinoma and was receiving systemic therapy. There were 3 cases of metastatic lung carcinoma; tissue was sufficient for molecular testing in 1 case in which 6 cores were obtained but insufficient in another in which only 2 cores were obtained. One patient was diagnosed with high-grade undifferentiated malignant neoplasm, probably sarcoma. Surgical resection or debulking was planned, but the patient opted for hospice care because of rapid progression. Tissue was adequate for flow cytometry in 2 of 3 lymphoma cases. One case demonstrated thymic carcinoid tumor, which was resected. In 1 benign case, an anthracotic-silicotic nodule was observed on core biopsy. The patient then underwent mediastinoscopy because bronchoalveolar lavage fluid had previously grown *Mycobacterium gordonae*, considered a contaminant. Mediastinoscopic biopsy demonstrated no malignant neoplasia or mycobacterial species. In another benign case, sclerosing mediastinitis was observed with core biopsy. A surgical procedure was planned but then canceled when follow-up CT showed that the mass had decreased in size.

One (6%) case was complicated by pneumothorax requiring a chest tube and overnight observation (Supplemental Figure 2). No other complications were encountered; all other patients were discharged on the day of the procedure.

COMMENT

Transsternal CT-guided anterior mediastinal 18-gauge core biopsy under moderate sedation is safe

TABLE Cases

Sex	Age (y)	Sedation	Preexisting diagnoses	Prior Bronchoscopy	Target (mm)	Needle	No. of Cores	Pathologic Result	Ancillary Studies	Clinical Outcome
M	66	MS	Mediastinal LAD	EBUS: negative; BAL: *M. gordonae*	16 x 25	OnControl/Mission	3	Anthracotic- silicotic nodule		Mediastinoscopy; AFB cultures and pathology negative
M	65	MAC	No known primary		27 x 41	Bonopty/Mission	5	Carcinoid tumor (thymic)	Sufficient for molecular and genetic testing	Pneumothorax; surgical resection
F	71	MS	COPD	EBUS: negative	53 x 64	OnControl/Mission	4	High-grade undifferentiated malignant neoplasm, favor sarcoma		Hospice; deceased 6 weeks after biopsy
F	40	MAC	No known primary		17 x 27	Bonopty/Temno	5	Lymphoma (DLBCL)	Sufficient for molecular, genetic testing and flow cytometry	Systemic therapy
M	56	MS	Hodgkin lymphoma		18 x 34	Temno	3	Lymphoma (NSCHL)	Insufficient for flow cytometry	Systemic therapy
M	58	GA	NSCLC		6x11	OnControl/Mission	2	Metastatic pulmonary adenocarcinoma	Insufficient for molecular testing	Radiation and systemic therapy
F	60	MAC	NSCLC		24 x 26	Bonopty/Temno	5	NSCLC		Systemic therapy; deceased 6 weeks after biopsy
M	78	MS	Black lung		19 x 23	OnControl/Mission	3	Sclerosing mediastinitis		Observation with decrease in size
F	64	MAC	Pulmonary nodules; COPD	Navigational bronchoscopy: negative	20 x 34	OnControl/Mission	6	Squamous cell carcinoma	Sufficient for molecular and genetic testing	Systemic therapy
F	50	GA	Breast cancer		27 x 34	OnControl/Mission	4	Thymoma		Thymectomy: thymoma type B1
F	68	MS	NSCLC		21 x 31	OnControl/Mission	3	Thymoma, WHO type A		Observation (systemic therapy for lung cancer)
F	51	MAC	Breast cancer		23 x 38	Bonopty/Temno	4	Thymoma, WHO type B1-B2		Robotic thymectomy
F	60	MAC	Breast cancer		27 x 41	Temno	3	Thymoma, WHO type B2		Observation (patient refused operation)
M	65	GA	Mediastinal LAD		15 x 34	OnControl/Mission	5	Thymus tissue		No further intervention
M	53	MS	Thyroid cancer		17 x 35	Madison/Temno	1	Nondiagnostic		Observation with no change

AFB, acid-fast bacilli; BAL, bronchoalveolar lavage; COPD, chronic obstructive pulmonary disease; DLBCL, diffuse large B-cell lymphoma; EBUS, endobronchial ultrasound bronchoscopy; F, female; GA, general anesthesia; LAD, lymphadenopathy; M, male; MAC, monitored anesthesia care; MS, moderate sedation; NSCHL, nodular sclerosis classic Hodgkin lymphoma; NSCLC, non-small cell lung cancer; WHO, World Health Organization.

and effective. Minimally invasive biopsy can preclude an operation and enable patients to receive appropriate systemic therapies. Percutaneous biopsy can be performed in an outpatient manner, avoiding hospitalization.

Anterior mediastinal masses may also be diagnosed by surgical biopsy or resection, such as with anterior mediastinotomy or Chamberlain procedures, although such approaches are mostly historical. Anterior mediastinotomy carries a 7% risk of morbidity, with a mean hospitalization of 2 days.[3] Complications include recurrent laryngeal nerve injury, pneumothorax, and bleeding. Video-assisted thoracoscopic surgical procedures cause more postprocedural pain than mediastinotomy, is associated with a 10% complication rate (eg, pneumothorax, esophageal perforation, chylothorax, and phrenic and left recurrent laryngeal nerve injury), and may be converted into open thoracotomy in 20% of procedures.[4]

Surgical approaches usually entail complete removal of the anterior mediastinal mass or thymus. Whereas this may be curative, there are downsides: many causes of mediastinal masses, such as lymphoma and metastatic carcinoma, are treated medically; resection would be an unnecessary operation. Recent data raise the concern for increased risk of all-cause mortality and cancer in patients after thymectomy.[5] Thus, if a benign thymoma is suspected on the basis of percutaneous needle biopsy, a less aggressive, limited resection may be possible. However, if thymic tumor is suspected, the National Comprehensive Cancer Network guidelines recommend surgical resection.[6] All operations involve intubation and potential hospitalization. In our case series, half of the patients underwent biopsy with moderate sedation, avoiding intubation, and most were discharged the same day.

Two prior studies investigated transsternal mediastinal core biopsy. One reported adequacy in 19 of 21 and no complications,[7] and the other reported adequacy in 15 of 17 and 9 complications.[8] Taking these studies together with this series, 49 of 54 (91%) yielded tissue adequate for diagnosis and 10 of 54 (18%) reported complications, although only 2 (4%) of the complications required further management.

In this study, the transsternal biopsy that was nondiagnostic involved only 1 core specimen. Of 6 cases in which ancillary studies were requested, all but 2 yielded enough tissue; these 2 cases involved collection of 2 or 3 cores, whereas the other cases involved collection of ≥5 cores. Experience in this series suggests that obtaining >3 cores may ensure adequate tissue for primary diagnosis and ancillary testing. Surgical excisional biopsy is considered the "gold standard" and preferred method for diagnosis of Hodgkin lymphoma according to National Comprehensive Cancer Network guidelines.[9] In this study, 3 of 3 lymphoma cases had specimens suitable for diagnosis, but only 2 had sufficient tissue for flow cytometry. More recent studies show that core needle biopsy provides accurate lymphoma diagnoses in >90% of cases.[10]

Percutaneous transsternal biopsy is associated with some challenges compared with other

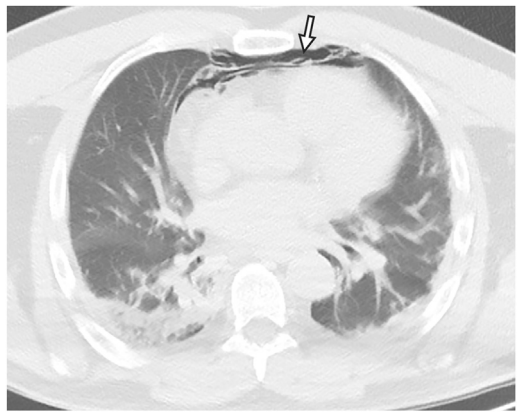

FIGURE 2 Pneumomediastinum. Because of negative intrathoracic pressure, air (arrow) can be introduced into the mediastinum during needle exchanges. Injection of a small amount of sterile gel can reduce gas introduced.

FIGURE 3 Anatomic considerations. Computed tomography image demonstrates internal mammary vessels lateral to the sternum (arrow) and the pericardium (arrowheads). Transsternal approach avoids internal mammary injury. Orienting the needle tangential to the pericardium reduces the risk of pericardial injury.

percutaneous biopsy procedures. Because of negative intrathoracic pressure, air may be introduced rapidly into the mediastinum (Figure 2). Of 9 complications reported in a similar prior case series,[8] 8 were "pneumomediastinum." In this study, injection of sterile gel into the coaxial guiding needle prevented air from entering the mediastinum, allowing multiple passes, accounting for the enhanced safety in this series. Second, a transsternal approach precludes reorientation of the needle trajectory once the guiding needle is through the cortex; the needle must be placed in an ideal trajectory before advancing into bone.

Compared with other percutaneous approaches, there are technical advantages. Parasternal approaches may cause life-threatening hemorrhage if mammary vessels are inadvertently damaged (Figure 3). Transpleural approaches increase the risk of pneumothorax. Finally, the serous pericardium is reflected around the roots of the great vessels; attention to the anatomic location of the pericardium, the aorta, and the great vessels is warranted to avoid pericardial effusion, tamponade, and vascular injury.

The primary study limitation is its small retrospective nature. Anterior mediastinal masses are uncommon, and it is not always clinically needed to biopsy these structures. Therefore, the procedure is uncommonly performed. It is unclear whether findings may be generalized to other settings or applied to clinical guidelines, given the small sample size and lack of a comparison group. However, findings illustrate minimally invasive techniques that can enable large-gauge cores to be obtained for diagnostic specimens and add to other small studies on this topic.[7,8] Small retrospective series are hypothesis generating and may justify consideration of alternative minimally invasive approaches, particularly in poor surgical candidates.

Transsternal core biopsy of anterior mediastinal lesions is feasible with CT guidance, moderate sedation, and minimal recovery time. This approach can obviate the need for more invasive surgical interventions and can provide adequate tissue for surgical pathologic examination and molecular testing.

The Supplemental Figures can be viewed in the online version of this article [https://doi.org/10.1016/j.atssr.2024.04.018] on http://www.annalsthoracicsurgery.org.

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