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Mediastinoscopy: Trends and Practice Patterns in the United States

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Abstract

Objectives—Historically, mediastinoscopy has been the gold standard for the staging of lung cancer. A practice gap exists as the result of a variation in knowledge concerning current trends and practice patterns of mediastinoscopy usage. In addition, there are regional variations in practice-based learning and patient care. Lessons learned during surgeries performed on patients with lung cancer and other advances such as positron emission tomography and endobronchial ultrasound could be universally applied to improve surgeons' management of patient care. The purpose of this study was to assess contemporary practices in the staging of lung cancer.

Methods—We queried the Society of Thoracic Surgeons National Database for data regarding mediastinoscopy usage, yield, and variation, both by year and region.

Results—Cases with mediastinoscopy, as a percentage of all cases performed in the database, have significantly decreased from 14.6% in 2006 to 11.4% in 2010 ($P < 0.001$). The 5-year median rate of mediastinoscopy in lung cancer patients at 163 centers was 15.3% (interquartile range 5.2%–31.7%), indicating significant variation among centers. The overall median center rate also decreased over time from 21.4% (2006) to 10.0% (2010).

Conclusions—With advances in minimally invasive procedures and imaging, mediastinoscopy usage has declined significantly. Our findings are likely to be relevant to both clinical practice and practice guidelines.

Keywords

mediastinoscopy; lung cancer staging; imaging; minimally invasive; diagnosis

Lung cancer staging is essential to selecting the most effective therapy and assessing a prognosis. Since the 1950s, mediastinoscopy has been the gold standard in evaluating the presence of mediastinal nodal metastases in patients with lung cancer. Carlens first performed mediastinoscopy in the 1950s and his technique is still in use today.[1] By 1964, patients were selected for the procedure if x-ray imaging demonstrated central tumors, atelectases, or oat-cell carcinoma. By that time, physicians had discovered that with mediastinoscopy, the resection rate had increased to 90%.[2] By 1969, mediastinoscopy was

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suggested for every case of operable bronchogenic cancer because it offered histopathological evidence and reduced higher-risk thoracotomy.[3] By 1976, researchers had determined that available radiographic techniques were insufficient to select patients for mediastinoscopy because of the prevalence of occult cancers.[4] As a result, it was determined that histology was more important than location in diagnosing metastasis. The incidence of mediastinoscopy has increased over time, with 16% of patients undergoing the procedure from 1986–1992, 32% of whom undergoing the procedure from 1993–2001.[5] In 1989, Lerut and colleagues developed video-assisted mediastinoscopy,[6] which was expanded in a clinical setting by Sortini and colleagues.[7]

In addition to its utility in staging lung cancer, mediastinoscopy is mandatory for lung resection in some medical centers. When compared with advances in minimally invasive procedures and imaging technology, mediastinoscopy is perceived by many surgeons to be exceedingly invasive. Many practitioners believe that advances in new technology and minimally invasive techniques can replace mediastinoscopy. The present study was undertaken to assess and evaluate contemporary practices in the staging of lung cancer by describing current trends and practice patterns of mediastinoscopy usage. In addition, regional variation in usage was assessed nationally, as was practice-based learning and patient care. The hypothesis is that lessons learned during surgeries performed on patients with lung cancer and new advances can be universally applied to improve surgeons' management of patient care. We expect that our findings will be relevant to both clinical practice and practice guidelines.

Methods

We reviewed the recent literature and consulted the Society of Thoracic Surgeons (STS) National Database for data regarding mediastinoscopy usage, yield and variation by year and region. The database, managed by the Duke Clinical Research Institute, was established for thoracic surgery in 2003 following the cardiac arm in 1989.[8] Since then, the database has flourished to become the largest database for reporting risk-adjusted outcomes in cardiothoracic surgery. All procedures were reviewed and approved by the University of Kentucky Office of Research Integrity. Statistical analysis was conducted using SAS 9.3 (SAS Institute, Cary, NC).

Results

Data from 163 centers representing 9749 patients undergoing lung cancer resection were analyzed. The mean age at surgery was 65.8 years of age with a standard deviation of 10.92. There were 4921 men and 4827 women with varying clinical and pathological TNM (TMN staging takes into account the size of the tumor [T], whether the cancer has spread to the lymph glands [lymph nodes, N], and whether the tumor has spread elsewhere else in the body [M, metastases]). staging. The number of cases per year, as a function of all STS thoracic cases, increased from 54,017 in 2006 to 93,517 in 2010. Cases with mediastinoscopy, as a percentage of all cases performed in the database, decreased from 14.6% in 2006 to 11.4% in 2010 ($P < 0.001$; Fig. 1). Yield, or detection of cancer, has remained similar during that period, at approximately 60% after an initial increase of 56.6%

in 2006. STS thoracic cases with lung cancer diagnosis have increased from 17,431 in 2006 to 32,123 in 2010. In the subset of cases with documented lung cancer, mediastinoscopy decreased from 25.6% in 2006 to 20.7% in 2010 ($P < 0.001$). Similar decreases are seen in isolated mediastinoscopy and in those performed with thoracotomy and resection ($P < 0.001$; Fig. 2).

The number of medical centers reporting STS thoracic cases with lung cancer diagnosis has increased from 66 centers in 2006 to 155 centers in 2010 ($P < 0.001$). When calculated by center, the 5-year median rate of mediastinoscopy in patients with lung cancer was 15.3% (interquartile range [IQR] 5.2%–31.7%), indicating significant variation among centers. The western centers in the database had higher mediastinoscopy utilization (n = 33, median 28.1% [IQR 10.3%–32.4%]) than southern centers (n = 62, median 12.6 [IQR 5.1%–27.6%]), with midwestern median centers' utilization at 13.7% and northeastern centers at 17.1%. The overall median center rate also decreased over time from 21.4% in 2006 to 10.0% in 2010 ($P < 0.001$).

Discussion

Many surgeons consider mediastinoscopy essential in the evaluation of lung cancer, but it is not without risk or limitation. Although standard mediastinoscopy allows for biopsy of mediastinal nodes up to level 7, this procedure cannot reach lymph nodes in levels 5 and 6. Conventional mediastinoscopy does not allow the surgeon to monitor directly the areas of dissection; however, extended mediastinoscopy can reach levels 5 and 6, as can the Chamberlain procedure. Sensitivity is reported to be approximately 87%[9] and specificity 100%. In addition, it does not provide access to the retrosternal space, subcarinal space, or left hilum.

Mediastinoscopy requires general anesthesia and has a morbidity of 0.3% to 3.0% and mortality of 0% to 0.05%, with accuracies of 83.8% to 97.2% and negative predictive values of 81% to 95.7%. Complications involved with mediastinoscopy include hemorrhage, pneumothorax, chylothorax, damage to the trachea or esophagus, hemorrhage, recurrent laryngeal nerve palsy, phrenic nerve injury, infection, air embolism, and usual risks associated with general surgery and anesthesia.[10] Video-assisted mediastinoscopic (VAM) lymph node biopsy has been shown to be safe, effective, and have fewer,[11] the same, or more minor complications[12] than traditional mediastinoscopy. VAM has results comparable to those of conventional mediastinoscopy in terms of mortality (0%), morbidity (0.83%–2.9%), accuracy (87.9%–98.9%), and negative predictive values (83%–98.6%).[13] The benefits of VAM include higher numbers of biopsies taken and the number of mediastinal lymph node states sampled, although more aggressive dissections can lead to higher rates of complications. Because of this, there is little evidence to support the superiority of VAM over conventional mediastinoscopy.[14]

Some surgeons perceive mediastinoscopy as exceedingly invasive and therefore recommend the selective use of the procedure in the staging of lung cancer. Even as radiographic techniques have developed in complexity from x-ray to computed tomography (CT) to fluorodeoxyglucose-positron emission tomography (FDG-PET) to combined FDG-PET/CT

and endobronchial ultrasound (EBUS), mediastinoscopy is still considered by many to be the gold standard in lung cancer staging.[15,16] The diagnostic efficacies of each staging modality vary with regard to accessible lymph node stations, sensitivity, and specificity (Table)[A]. A comprehensive review of the diagnostic efficacy of invasive and noninvasive modalities for the diagnosis of lung cancer is beyond the scope of this article. Surgeons select staging modalities based on their diagnostic efficacies in combination with their knowledge of the lymph node stations, the lymph nodes accessible by each staging modality, and clinical judgment.

PET has been found to be more accurate in staging than CT[28] and superior in both sensitivity and specificity.[29] A comparison of PET scans with histopathological results found that 86% of patients were correctly staged with a PET scan, although the positive predictive value was low (46%) and the negative predictive value was high (97%). The high negative predictive value of PET indicated that mediastinoscopy could be omitted with a negative scan and that the patients then proceed to thoracotomy.[30] Researchers believe that FDG-PET improved diagnostic accuracy compared with conventional PET imaging. Although CT had limited success in staging, it could guide the physician in selecting staging tools, performing biopsy, and anatomically correlating with FDG-PET images. Many have suggested that the two should be considered complementary rather than competitive imaging strategies.[31]

Some studies reported a lower accuracy rate for PET than previously found, but confirmed its high negative predictive value.[32] It was asserted that PET must be combined with CT, because the combination of the two offered twice the sensitivity and that a positive PET scan indicated the need for further diagnostic procedures such as mediastinoscopy[32]; thus, the emergence of combined PET/CT as a better diagnostic tool began to solidify. If mediastinal PET-CT is negative, then the risk of occult metastatic disease is low and invasive techniques may not be indicated; however, abnormalities on PET-CT must be confirmed by mediastinal staging because of the risk of false-positives.

FDG uptake is nonspecific and can be detectable on PET-CT in many pathologies, including but not limited to inflammations, tuberculosis, sarcoidosis, cryptococcosis, paragonimiasis, radiation fibrosis, pneumonoconiosis, sclerosing hemangioma, granulation around tissue, and other infectious conditions. In addition, PET-CT has a risk of false-negative findings involving tumors with low metabolic activity, metastasis of extrapulmonary neoplasm, chemotherapy, carcinoid tumor, hyperglycemia, or small tumor size. Metabolic imaging with FDG-PET is an important complement in the overall evaluation of malignant disease but should not be used exclusively for diagnosis.[33] Studies have shown that CT is highly suggestive but not diagnostic, and the use of PET-CT for preoperative staging of non–small cell lung cancer has reduced both the number of futile thoracotomies and the total number of thoracotomies, but it did not affect overall mortality.[34]

EBUS is gaining popularity because of its ease of performance and the ability to access nodes below level 7. In addition, endoscopic ultrasound can be performed simultaneously

[A]Refs must be cited in numerical order. The Table refs were out of order, so refs were renumbered in text and in the ref list.

and can access posterior mediastinal nodes, including node 12. Endoscopic ultrasound is a minimally invasive technique that reaches the posterior mediastinum with few, if any, complications and can be performed as an outpatient procedure. The technique cannot reach the anterior mediastinum because it cannot cross the trachea, but the new technique of EBUS-guided transbronchial needle aspiration biopsy (EBUS-TBNA) may fill that gap. Practitioners are hopeful that these minimally invasive techniques can replace mediastinoscopy.[35]

The diagnostic efficacy of EBUS is comparable to mediastinoscopy; however, its negative predictive value is so low that it cannot replace the former, but should become a complementary technique. Like mediastinoscopy, EBUS-TBNA is performed by local and general anesthesia, but it is less invasive and has fewer complications. EBUS-TBNA may evolve to become complementary to mediastinoscopy and be used as an initial staging modality that may or may not require subsequent mediastinoscopy. EBUS is limited in its national utilization by its requirement for a surgical cytopathologist; consequently, success depends on the experience of the cytopathologist and the number of passes. When compared to each other, EBUS-TBNA and mediastinoscopy have similar accuracy (93%), sensitivity (80%), specificity (100%), negative predictive value (90.5%), and positive predictive value (100%), although EBUS-TBNA is limited by its inability to characterize lymph nodes smaller than 5 mm in diameter. In a study of patients with inoperable non–small cell lung cancer, both modalities had similar diagnostic yield (89%).[36]

Accurate mediastinal staging is essential to the management of patients with lung cancer, and there is a need for minimally invasive, high-yield, low-morbidity procedures for the diagnosis of lung cancer. In 1969, mediastinoscopy was the best way to positively diagnose cancer and other thoracic disease, having reduced high-risk exploratory thoracotomies.[37] Physicians in the 1970s attempted to formulate criteria for selecting patients for mediastinoscopy, but found radiographic techniques at the time to be lacking in both positive and negative predictive value. They discovered that histological tumor type was as important as radiographic evidence from chest x-ray in predicting nodal metastases, particularly parenchymal masses, or peripheral lesions.[38] When other less invasive radiographic procedures emerged, they could not offer histological proof of diagnosis, although they quickly gained prevalence. Physicians had been excited by the hope of accurate and affordable noninvasive cancer staging that CT seemed to offer and now that excitement was being generated by PET-CT. Unfortunately, the research did not yield high sensitivities and specificities for CT or PET, and each had its drawbacks, such as occult metastases and false-positives. Studies by surgeons have found that mediastinoscopy is not obsolete and that contrary to other studies, it can identify lymph node involvement that is radiographically occult and help to avoid unnecessary resections. It also can identify patients with advanced disease before resection and allow them to begin neoadjuvant therapy before surgery.[39,40]

The median percentage of mediastinoscopy has declined both by center and nationally. Although regional variation exists among centers in the United States, it is not known why this variation exists. Variability exists in many other procedures and may reflect the training, experience, and biases of individual physicians in the United States.

Conclusions

Mediastinoscopy has been the gold standard for the staging of lung cancer since the 1950s and in some centers is mandatory for lung resection. With advances in staging modalities, including minimally invasive procedures and imaging technology, the use of mediastinoscopy has declined nationally over time. It is evident that the median percentage of mediastinoscopy cases has decreased by center as well as nationally. Techniques such as EBUS and advances in imaging are becoming the paradigm in mediastinal staging of lung cancer as rates of mediastinoscopy decline. Minimally invasive procedures may reduce the cost and risks of surgical procedures and may preclude more invasive procedures. Alternatively, invasive techniques provide tissue that can be used for cytological and histological examination, diagnosis, and prognosis and are necessary for all clinical presentations. It is believed that the increasingly frequent use of imaging and minimally invasive procedures has caused a decrease over time of invasive procedures such as mediastinoscopy.

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Key Points

- Cases with mediastinoscopy as a percentage of all cases performed in the Society of Thoracic Surgeons National Database has decreased from 14.6% in 2006 to 11.4% in 2010 ($P < 0.001$), whereas detection of cancer (yield) has remained similar during this period, at approximately 60% after an initial increase from 56.6% in 2006 ($P < 0.001$).
- In the subset of cases with documented lung cancer, mediastinoscopy has decreased 25.6% in 2006 to 20.7% in 2010 ($P < 0.001$). Similar decreases are seen in isolated mediastinoscopy and those performed with thoracotomy and resection ($P < 0.001$).
- The 5-year median rate of mediastinoscopy in lung cancer patients was 15.3% (interquartile range 5.2%–31.7%), indicating significant variation among centers.
- The overall median center rate also has decreased over time, from 21.4% in 2006 to 10.0% in 2010.
- With advances in staging modalities, including minimally invasive procedures and imaging technology, the use of mediastinoscopy has declined nationally over time.

Brief Description

Lung cancer staging is essential to selecting therapy and assessing prognosis. Mediastinoscopy has been the gold standard for the staging of lung cancer since the 1950s and in some centers is mandatory for lung resection. With advances in minimally invasive procedures and imaging technology, mediastinoscopy is perceived by many surgeons to be exceedingly invasive. Advances in technology and techniques such as positron emission tomography and endobronchial ultrasound make practitioners hopeful that minimally invasive techniques can replace mediastinoscopy. The purpose of this study was to assess contemporary practices in the staging of lung cancer.

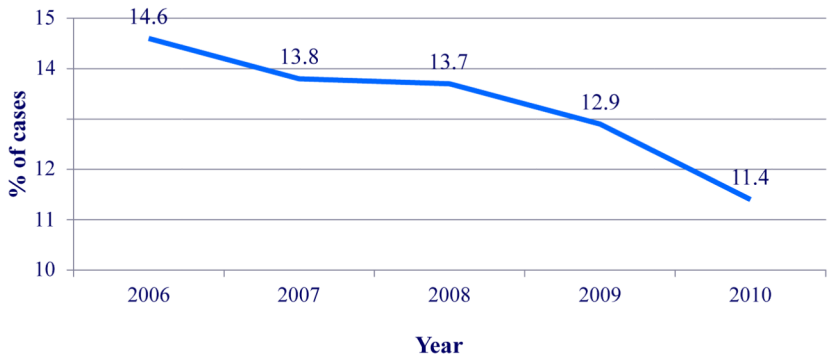

Fig. 1.

Cases with mediastinoscopy performed as a percentage of all Society of Thoracic Surgeons thoracic cases has decreased ($P < 0.001$).

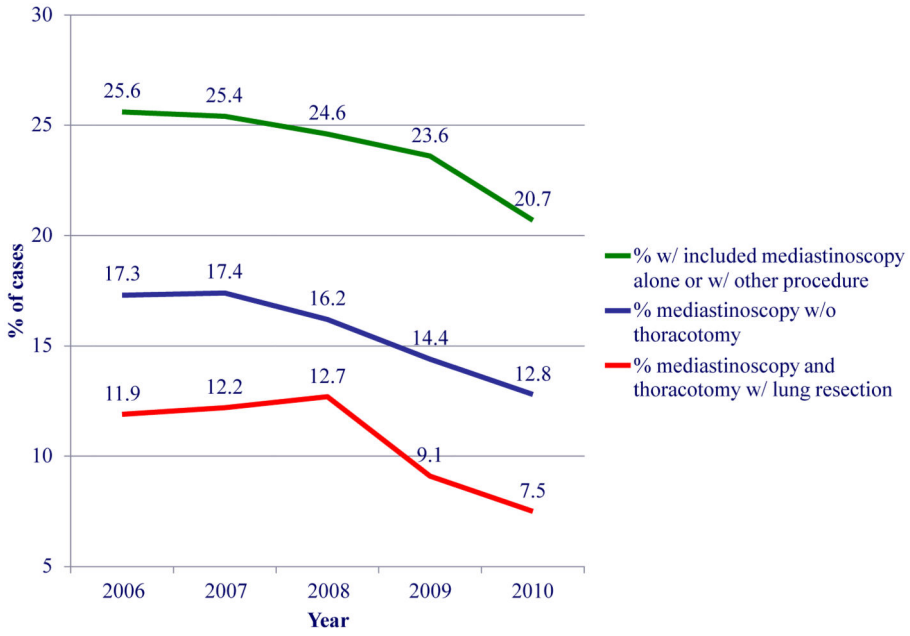

Fig. 2.
Society of Thoracic Surgeons cases with lung cancer diagnosis.

Table

Comparison of diagnostic efficacies in staging modalities

	2R	2L	3	4R	4L	5	6	7	8	9R	9L	10R	10L	11R	11L	Sensitivity	Specificity	Source
Mediastinoscopy	X	X		X	X			X								80	100	Lemair et al[17] Schouwinket al[18] De Leyn et al[19]
Chamberlain procedure						X	X									87	100	Detterbeck et al[20]
Transcervical extended cervical mediastinoscopy	X	X	X	X	X	X	X	X	X							45–51	100	Detterbeck et al[20]
Transbronchial-FNA without ultrasound	X	X	X	X	X	X		X								76	96	De Leyn et al[19]
EBUS-FNA	X	X	X	X	X	X		X				X	X	X	X	87.9–92.3		Yasufuku et al[21]
EUS-FNA			X		X	X		X	X	X						88	91–100	De Leyn et al[19] Detterbeck et al[20]
Transthoracic percutaneous FNA with CT guidance				X	X	X	X									91	100	Detterbeck et al[20]
VATS with biopsy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	98.3	100	Venissac et al[22]
Thoracotomy	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			Whitson etal[23]
FDG-PET																61.1–94.1	79–94.3	Lee et al[24] Kernstine et al[25] Graeter et al[26] Gonzalez- Stawinski etal[27]
CT																57	82	De Leyn et al[19]
Combined PET/CT																85.7	80.6	Lee etal[24]

CT, computed tomography; EBUS, endobronchial ultrasound; EUS, esophageal endoscopic ultrasound; FDG-PET, [18F]-fluorodeoxyglucose-positron emission tomography; FNA fine-needle aspiration; VATS, video-assisted thoracoscopic surgery.