Electromagnetic navigational bronchoscopy in patients with solitary pulmonary nodules

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Abstract

Background: *Electromagnetic navigational bronchoscopy (ENB) is a tool used to help the bronchoscopist reach target lesions in the lung which would otherwise be very difficult or impossible to reach. There is ongoing debate about the usefulness of ENB.*

Methods: *A retrospective review of all patients with a solitary pulmonary nodule who underwent ENB between August 2010 and November 2013 was done. An analysis of the four common tools used to sample the lung through ENB at Texas Tech University Health Sciences Center in Lubbock, including transbronchial biopsy (TBBx), transbronchial needle aspiration (TBNA), transbronchial brush, and bronchoalveolar lavage (BAL), was performed. Results were analyzed to calculate the diagnostic yields of these tools.*

Results: *A total of 64 patients were analyzed. For all conditions, the diagnostic yields were 71%, 50%, 28%, and 23% for TBBx, TBNA, brush, and BAL, respectively. For patients with a malignant diagnosis the diagnostic yields were 75% for TBBx, 73% for TBNA, 41% for brush, and 30% for BAL.*

Conclusions: *The transbronchial biopsy and transbronchial needle aspiration were the most useful tools. The transbronchial brush and BAL had very low diagnostic yields and did not add to the diagnostic yield of lung cancer over that of TBBx or TBNA.*

Keywords: electromagnetic navigational bronchoscopy, transbronchial biopsy, transbronchial needle aspiration, lung cancer, solitary pulmonary nodule

Introduction

Electromagnetic navigational bronchoscopy (ENB) is a technique used by bronchoscopists to guide sampling tools which may provide higher diagnostic yields with peripheral infiltrates and nodules. Electromagnetic navigational bronchoscopy uses an electromagnetic field and a computed tomography scan to guide an extended working channel from the tip of the bronchoscope to the target lesion using a locatable guide placed at the end of the extended working channel. When the peripheral target is reached, the locatable guide is removed leaving the extended working channel in place. Several tools can then be inserted though the extended working channel to sample the peripheral lesion. A recent multicenter trial of ENB use in peripheral lung lesions found that the diagnostic yield for ENB was lower than expected.[1] Their data conflicted with other publications on ENB yields, which are between 63-74%.[2] Our study evaluates the diagnostic yield of the different tools in sampling solitary pulmonary nodules at the Texas Tech University Health Sciences Center in Lubbock, Texas.

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Methods

The use of ENB at the TTUHSC in Lubbock, Texas, was reviewed using a retrospective study design approved by the Institutional Review Board. Adult patients undergoing ENB with solitary pulmonary masses or nodules between August 2010 and November 2013 were selected for inclusion. The goal of the study was to analyze the diagnostic yields of the different tools available for use through the extended working channel of the ENB system. During this study we exclusively used the Medtronic Covidien super Dimensions™ system with iLogic version 6 software with Edge™ extended working channel catheters. Four tools were chosen for analysis, including transbronchial biopsy (TBBx), transbronchial needle aspiration (TBNA), transbronchial brush, and bronchoalveolar lavage (BAL). For all TBBx, a standard cup forceps without a needle was used. Five biopsies were taken from the target lesion. Transbronchial needle aspirations were performed using a 21 gauge needle. Two passes were obtained from the target lesion with TBNA. A standard 1.7mm diameter 120mm long protected cytology brush was used for the brush biopsies. The brush was advanced into the target lesion one time, agitated, and then withdrawn. A single BAL was performed through the extended working channel after the other tools had been used. Ten milliliters of fluid were instilled, and hand suction was applied while the bronchoscope and the extended working channel were withdrawn. Since we did not have radial EBUS capabilities during this study period, all peripheral sampling was performed with only the ENB platform and fluoroscopy.

Analysis was performed on the individual tool results and on combined results for an overall performance analysis. A tool was labeled as having a positive result if a formal diagnosis was made, either malignant or benign. A positive benign result was defined as any finding other than inflammation, atypical cells, or normal lung tissue. A tool was labeled as having a negative result if a pathologic determination could not be made or the result was read as inflammatory tissue, inflammation, hemorrhage, or atypical cells not further classified. Patients with a benign diagnosis were followed out to one year. If the lesion did not change with serial CT imaging, this was considered a true negative.

A separate analysis was then performed on patients who ultimately were diagnosed with malignancy. A true positive was defined by a positive ENB result in a patient who ultimately did have a malignancy. A false negative was defined by a negative ENB result in a patient who ultimately did have a malignancy. A true negative was defined by a negative ENB result in a patient who ultimately had no malignancy. A false positive result was defined as a patient who had a positive result by ENB but ultimately did not have a malignancy.

Results

A total of 64 patients met the inclusion criteria. Forty-two patients were men, and 22 were women. The ages of the patients ranged from 18 to 89 years of age. The sizes of the lesions were 9-46 mm with a mean ± SD of 23 ± 9 mm. The mean ± SD distance from the carina to the target lesion was 84 ± 23 mm, and the mean ± SD distance from the chest wall to the target lesion was 37 ± 20 mm.

Of the 64 patients reviewed in this study, 62 patients had TBBx performed, 30 had TBNA performed, 36 had a transbronchial brush performed, and 56 had BAL performed. Forty-seven patients had a diagnosis by at least one of the tools used during ENB for an overall yield of 76%. A diagnosis was made by biopsy 44/62 times it was used (diagnostic yield = 71%), by transbronchial needle aspiration 14/28 times it was used (diagnostic yield = 50%), by brush 10/36 times it was used (diagnostic yield = 27%), and by BAL 13/56 times it was used (diagnostic yield = 23%). Benign diagnosis included fibrosis, alveolar hemorrhage, amyloidosis, Langerhans cell histiocytosis, granulomatous disease, abscess, histoplasmosis, and mucormycosis.

Procedures in which all four tools were used were then analyzed, offering, by proxy, a head to head comparison. There were 13 patients out of the 64 in whom all tools were used. Nine patients received specific diagnoses, and four patients did not have a final diagnosis. Biopsy was diagnostic 7/13 times

(diagnostic yield = 54%), TBNA was diagnostic 7/13 times (diagnostic yield = 54%), brush was diagnostic in 4/13 patients (diagnostic yield = 31%), and BAL was diagnostic 4/13 patients (diagnostic yield = 31%). There were no false positive results.

Patient	Biopsy	FNA	Brush	BAL
1	+	+	NA	+
2	+	NA	-	-
3	+	NA	NA	-
4	+	-	+	+
5	+	+	-	+
6	+	+	+	+
7	+	NA	NA	-
8	+	NA	-	-
9	+	+	+	+
10	+	+	NA	NA
11	+	Na	NA	NA
12	+	+	+	+
13	+	+	+	+
14	+	NA	+	NA
15	+	+	+	+
16	+	NA	NA	-
17	+	NA	NA	-
18	+	NA	NA	-
19	+	NA	NA	-
20	+	-	NA	-
21	+	NA	NA	-
22	+	+	NA	-
23	-	+	-	-
2	-	NA	-	-
25	-	NA	-	-
26	-	-	-	-
27	-	NA	-	-
28	-	+	-	-
29	-	-	-	-
Total Sensitivity	75%	73%	41%	30%

Table The breakdown of tools by each patient with a confirmed malignant diagnosis.

Column 1 is the patient number. Columns 2-5 are the results for TBBx, TBNA, transbronchial brush, and BAL, respectively. A + indicates a true positive (the rectangle was highlighted for clarity). A – indicates a false negative. NA indicates that the tool was not used in this patient.

Of the 64 patients studied, 29 (45%) patients had a final diagnosis of malignancy. In these 29 patients, ENB was positive for malignancy in 24 (82%). Twenty-two patients (75%) had a positive diagnosis for malignancy by biopsy. Fine needle aspiration was positive for malignancy in two additional patients. Transbronchial brush specimens and BAL did not add to the diagnostic yield for malignancy. Malignant diagnosis included 11 cases of squamous cell carcinoma, 11 cases of adenocarcinoma, three cases of non-small cell carcinoma not further specified, two cases of small cell lung cancer, one large cell carcinoma, and one lymphoma.

Nine patients out of the 64 were lost to follow up and did not receive a final diagnosis.

Discussion

Forceps have been the most widely used tool for obtaining tissue from the lung through the use of transbronchial biopsies. A forceps biopsy was used in almost every case of this study. It was the most useful tool with a diagnosis obtained 71% of the time in the whole study population and 75% of the time when the final diagnosis was malignancy. There were five false negative cases. These results suggest that a transbronchial biopsy should be performed every time a solitary pulmonary nodule is sampled.

The transbronchial needle aspiration has been used for over 30 years for evaluation of mediastinal adenopathy and peripheral pulmonary nodules. There has been renewed interest in TBNA with the advent of endobronchial ultrasound which appears to increase yields.[3] Transbronchial needle aspiration was the second most useful tool with a diagnostic yield of 50%. However, when only analyzing cases of malignancy, TBNA had a diagnostic yield of 73%. This tool was underutilized in the study, being used only 43% of the time in all cases and 51% of the time when malignancy was diagnosed. Transbronchial needle aspiration yielded a positive malignancy diagnosis when

all other tools were negative twice. Our data suggest that TBNA should be used along with transbronchial biopsy in every case.

The transbronchial brush has been widely used in peripheral lesions with the expectation that the surface area of the brush would provide a higher likelihood of a diagnostic sample. This has been thought to be especially true for small lesions without a bronchus sign, an airway leading into the target lesion by CT scan. The brush was the third most utilized tool (56% of the cases); however, the diagnostic yield was poor with a positive result in only 10/36 cases that it was used. Diagnosis in malignancy was also poor with a diagnostic yield of 41%. The brush was never the sole contributor to the diagnosis in any case. The false negative rate was also very high. Our data indicate that the brush does not add to the diagnosis but adds time and cost to the patient. We suggest that the brush should not be routinely used in the sampling of solitary pulmonary nodules.

The BAL has been a versatile tool in the evaluation of multiple pulmonary pathologies. With ENB it can provide both cultures for infectious disease and cytological studies in the evaluation for malignancy. During this study, the BAL was used after the other tools, thinking that the agitation of cells from airway manipulation would yield better diagnostic results. However, the diagnostic yield was low. Many samples from the BAL returned atypical cells of uncertain significance. The BAL did return a diagnosis when infection was the cause of the solitary pulmonary nodule; however, at least one other tool was also positive when the BAL was positive. While the BAL is not very sensitive, the ease of use and the very good safety profile will likely mean continued utilization.

This study has several limitations. First, it was a single institution study with a small study population. Second, patients with non-specific diagnoses were followed out to one year to assess for imaging changes before being labelled as having a benign disease. However, some patients were lost to follow up or had incomplete follow up. Last, the navigational equipment being used at the time of this study is outdated compared to current equipment. The tools used during this study have also evolved; superDimension™ (Medtronic PLC, Minneapolis, MN) now makes a triple needle brush which may provide higher yields for both needle aspiration and brush sampling.

Conclusions

This study reports our experience with ENB using the superDimension™ navigational bronchoscopy system (Medtronic PLC, Minneapolis, MN) for solitary pulmonary nodules in routine clinical practice. We found that out of the four tools available, the transbronchial biopsy and transbronchial needle aspiration had the highest diagnostic yields. The transbronchial brush and BAL had very low diagnostic yields, questioning the utility of these tools in the evaluation of solitary pulmonary nodules.

We suggest that biopsy and needle aspiration should be used for sampling every solitary pulmonary nodule. We did not find utility with the brush and suggest that it not be used in most cases. The BAL in theory can provide a diagnosis in cases without malignancy. Given the ease of use and safety of BAL, we recommend its continued use in the evaluation of solitary pulmonary nodules. Larger studies have had similar results, but with large variability in diagnostic yields between institutions.[1] Future studies should determine if diagnostic yields improve following advancement in the tools and navigational platforms. A newer navigational platform has incorporated transthoracic needle aspiration (TTNA) with a seamless integration into the diagnostic workflow of solitary pulmonary nodules. The reported yields using a systematic approach are promising.[4]

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