Role of lung point navigation bronchoscopy in diagnosis of peripheral pulmonary lesions

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Background
Cancer of the lung is the leading cause of mortality worldwide. There is a continuing problem to treat patients with pulmonary lesions in the peripheral lung. Technology like virtual bronchoscopic imaging is based on assisted-computed tomography pictures that lead the bronchoscopist to the target peripheral lesion.
Objectives
The purpose of this research was to evaluate the safety and effectiveness of the lung point navigation system in the identification of peripheral pulmonary lesions.
Patients and methods
A total of 20 patients took part in this cross-sectional investigation, which used analytical methods. Finally, tissue samples from peripheral pulmonary lesions were collected using virtual bronchoscopic navigation.
Results
Overall, 90% of the cases analyzed were correctly diagnosed using lung point navigation, whereas 10% of the cases were incorrectly diagnosed. The lesion was on average 22.4 mm×23 mm in size, 17.2 mm away from the costal border, and 102.5 mm away from the diaphragm. The average navigation time was 7.4 min, whereas the average planning time was 5 min, and the overall examination duration was 31 min.
Conclusion
The navigation bronchoscopic method is a promising innovation in the field of lung disease diagnostics. Cost, operational skills, and the learning curve have all conspired to keep it from being widely used thus far.

Keywords:
lung cancer, navigation bronchoscopy, peripheral pulmonary lesions

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Introduction

Cancer-related fatalities owing to lung cancer in the United States and globally total greater than the combined deaths owing to colon, breast, and prostate cancers [1].

A major obstacle to treating lung cancer is the inability to locate lesions early enough for tissue collection despite advancements in diagnostic methods, staging, and therapy [1].

Unnecessary procedures, such as surgery, can be avoided by using a safer and more accurate procedure to investigate and diagnose suspicious lung lesions, especially those located above the subsegmental level of the lung. This will allow for an earlier diagnosis of the lesion with fewer complications. One such computed tomography (CT) image-based approach that aids bronchoscopists in reaching the lesion is virtual bronchoscopy. Helical CT continuous volume data may be used to create 3D pictures of tracheal and bronchial lumens as if they were viewed on bronchoscopy [2].

Based on simulated pictures of the respiratory system, lung point navigator helps lead the bronchoscopist to peripheral lesions [3].

The purpose of this research was to evaluate the safety and effectiveness of the lung point navigation system in the identification of peripheral pulmonary lesions.

Patients and methods

The bronchoscopy unit of the chest hospital of the armed forces medical complex at Kobri Al-Kobba was used to conduct this cross-sectional analytic investigation between January 2021 and December 2021.

This research included 20 participants. Documentation of patients' histories, including their age, sex, and

smoking status, was completed for all participants in the trial. Medical history and physical examination were done. CBC, LFTs, KFTs, ESR, ABG, and coagulation parameters such as PT, PTT, and INR are examples of common laboratory tests.

(1) Postero-anterior radiography of the chest was performed.
(2) A DICOM extension CT image of the chest was imported into the lung point system.

Tissue samples from peripheral pulmonary lesions were obtained with the use of virtual bronchoscopic navigation (VNB) on these individuals. The study was approved by the Benha University's ethics board. For the VNB operation, a written informed consent was obtained from all patients.

When a DICOM-formatted CT scan is entered into the system, the airway is automatically removed and processed. Finally, cross-sectional CT pictures are shown in all three directions.

On a CT scan, we used a three-dimensional spherical marker to identify the target lesion.

The three-dimensional item was automatically segmented by the program. Once the desired item has been positioned, the computer program determines the best route to take to bring it there.

Both live bronchoscopic footage and an animation were shown on screen at once during bronchoscopy.

The animation depicts the route chosen during the preplanning stage. Images are aligned with the live video using an image-based synchronization approach.

After synchronizing the two pictures, the program used this information to determine where the bronchoscope was positioned in the airway and then overlaid a route to the target on the real video image.

An ultrathin bronchoscope was used by a qualified bronchoscopist to conduct a general anesthetic biopsy. The bronchoscope was maneuvered with lung point as close as feasible to the target after the bronchial tree, including the subsegmental bronchi, had been thoroughly examined. Transbronchial lung biopsy was used to continue the treatment after it had reached its objective.

To conduct histological examinations, samples were collected.

It was necessary to fix all samples in 10% formalin for at least 24 h before pathological examination [4].

Patients' vital signs, including pulse, blood pressure, and oxygen saturation, were closely monitored during their stay.

After a bronchoscopy, any problems (such as hemoptysis, pneumonia, nausea, and vomiting, among other things) were documented and handled appropriately.

Follow-up was done after 1 week to confirm the finding of histopathological investigation.

Case presentation

A 58-year-old man was admitted to our hospital with cough, sputum, and left chest discomfort that had persisted for more than a week. Antibiotics were administered orally to the patient (amoxicillin). However, there was no relief from the symptoms. Neither dyspnea nor fever or chills accompanied his lack of energy. There was no history of hypertension or diabetes in this patient. No history of special habits. Not much was revealed through his ancestry.

He was found to have no crackles or wheezes in his lungs during a physical examination. There were infiltrates in both lungs, upper and lower, on the chest CT scan when the patient was admitted. The left lower lobe was discovered to have a solid lung nodule. 'Community-acquired pneumonia' was the first diagnosis. Biapenem 0.3 g, i.v., 1/8 h, and levofloxacin 0.5 g, i.v., qd were used to treat him. A week later, most of the symptoms disappeared. After a month, the lesions on the CT scan had cleared up by more than half. There was essentially no difference in the pulmonary nodule located in the lower left lobe of the lung between the two CTs. The results of a 3-month follow-up CT scan were noted.

CT chest showing left lower lobe nodule after 3 months.

The target lesion in the lung point navigation bronchoscopy.

Pathological examination revealed that the patient had an adenocarcinoma with an advanced stage of differentiation, which was confirmed by a VNB biopsy collected and submitted to histopathology.

Results

Most patients were complaining of cough, dyspnea, and expectoration (95, 60, and 60%, respectively),

Table 1 Pulmonary symptoms of the studied groups (*N*=20)

Variables	*n* (%)
Pulmonary symptoms	
Cough	19 (95)
Expectoration	12 (60)
Dyspnea	12 (60)
Chest pain	7 (35)
Hemoptysis	4 (20)
Constitutional manifestations	7 (35)

Table 2 Characteristics of the pulmonary lesions in computed tomography of the studied patients

Variables	(*N*=20) *n* (%)
Lesions site	
Right upper	6 (30)
Right lower	2 (10)
Left upper	3 (15)
Left lower	5 (25)
Right upper and lower	1 (5)
Right upper, middle, and lower	1 (5)
Right and left lower	2 (10)
Number of lesions	
One lesion	12 (60)
Two lesions	5 (25)
Three lesions	1 (5)
Four lesions	1 (5)
Five lesions	1 (5)
Lesion size	
Length (mm)	
Mean±SD (range)	22.4±5.8 (10–28)
Width (mm)	
Mean±SD (range)	23±6.3 (10.5–29)
Lesion margin	
Irregular	8 (40)
Speculated	5 (25)
Lobulated	1 (5)
Smooth	6 (30)

Table 3 Lung point navigation time (in min) and planning time (in min)

Variables	*N*=20
	Mean±SD (range)
Lung point navigation time (min)	7.4±0.8 (6–9)
Planning time (min)	5±0.3 (4.5–5.5)

whereas those who were complaining of chest pain and hemoptysis were 35 and 20%, respectively. Moreover, 35% of studied patients had constitutional symptoms (Table 1).

Generally, the lesions were 22.4 mm×23 mm in size, 17.2 mm from the costal border, and 102.5 mm from the diaphragm on average (Table 2).

There was a mean time of 7.4 min per lung point navigation, a mean planning time of 5 min, and a total test duration of 31 min (Table 3).

Table 4 Lung point navigation sensitivity in diagnosis of the studied patients

Navigation success	(*N*=20) *n* (%)
Success	18 (90)
Failure	2 (10)

Table 4 shows that lung point navigation was successful in 90% of the instances analyzed and unsuccessful in 10% of the cases.

Overall, 56% of the pulmonary nodules in this research were malignant, 25% were benign, and 10% were undiagnosed, according to the results of this investigation, as indicated in Fig. 1.

A total of five (27.8%) nodules were found in the right upper region, one (6.5%%) in the right lower region, three (16.7%) in the left upper region, five (27.8%) in the left lower region, and one (5.6%) in the right upper, middle, and lower regions. However, the nodules are still unidentified, one from each upper and lower. Solitary nodules accounted for 88.8% of all diagnostic nodules, whereas multinodule nodules accounted for 50% of all undiagnosed nodules. All individuals identified with LN involvement received a diagnosis (Table 5).

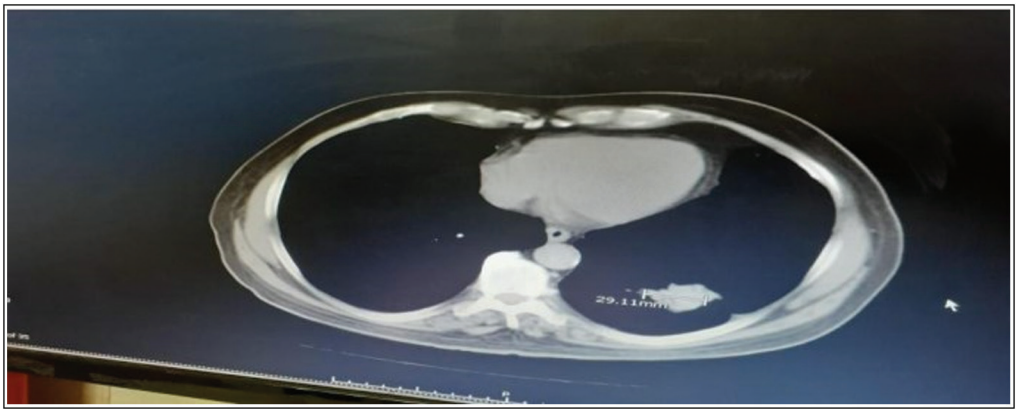
There was a statistically significant difference in the nodule size between diagnosed and undiagnosed individuals (P=0.038). Diagnosed individuals had a mean depth from the costal edge of 17.32 mm (P=0.42), compared with 16.35 mm for undiagnosed patients. Diaphragm depth was greater in individuals who had been diagnosed (107.04 mm) than in those who had not been (61.65 mm) (P=0.001) (Fig. 2).

Table 6 shows that no complications occurred in 85% (17/20) of cases except for bleeding in 10% (2/20) of cases and hypoxemia in 5% (1/20) of cases. All cases of the study were vitally and generally stable at the end of the procedure, and there was no need for ICU observation. Follow-up of all of 20 cases reported no deaths after the procedure.

Discussion

There are several endobronchial sample procedures to reach these difficult-to-reach lesions safely and reliably [5], and a variety of diagnostic approaches are available, each with its own set of risks and benefits. It is difficult to locate and get the necessary tissue using standard methods such as bronchoscopy. Similar to computed-assisted transthoracic needle biopsy, the preferred diagnostic procedure currently has complications such as pneumothorax and hemorrhage [3]. This study

Figure 1

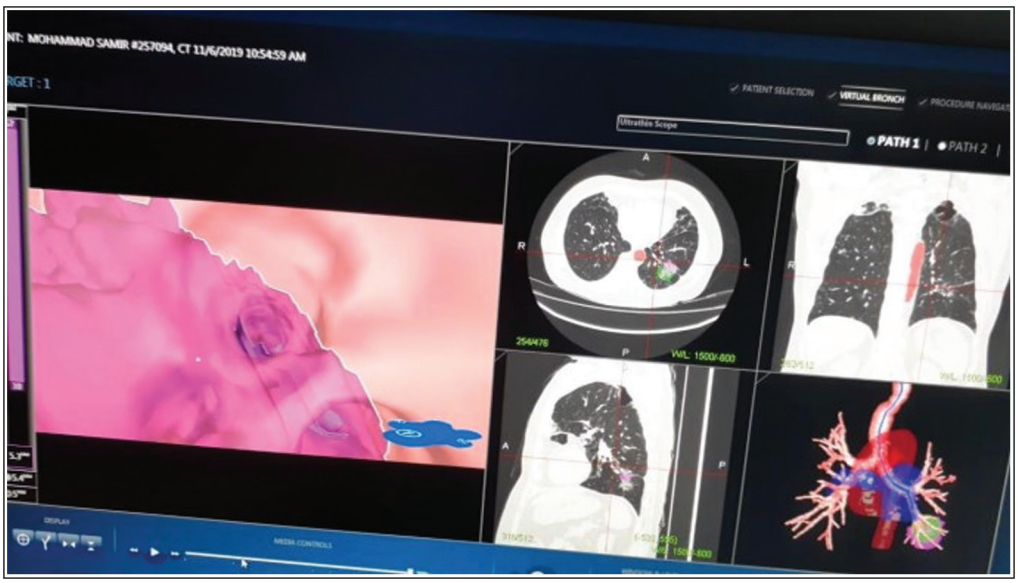


Histopathological diagnosis of the pulmonary lesions using bronchoscopic lung biopsy forceps.

Table 5 Comparison of diagnosed and undiagnosed nodules: numerical variables

Variable	Diagnosis of nodule [*n* (%)]		Total (*N*=20) [*n* (%)]	Test	*P*
	Diagnosed (*N*=18)	Undiagnosed (*N*=2)			
Lesions site					
Right upper	5 (27.8)	1 (50)	6 (30)	FET=6.1	0.59
Right lower	1 (6.5)	1 (50)	2 (10)		
Left upper	3 (16.7)	0	3 (15)		
Left lower	5 (27.8)	0	5 (25)		
Right upper and lower	1 (5.6)	0	1 (5)		
Right upper, middle and lower	1 (5.6)	0	1 (5)		
Right and left lower	2 (11.1)	0	2 (10)		
Number of lesions					
Solitary	16 (88.8)	1 (50)	12 (60)	χ^2=0.09	0.76
Multiple	2 (11.1)	1 (50)	8 (40)		
LN involvement					
+ ve	4 (22.2)	0	4 (20)	χ^2=0.56	0.46
-ve	14 (77.8)	2 (100)	16 (80)		

Figure 2



Comparison of diagnosed and undiagnosed nodules among studied patients.

Table 6 Complications of navigational bronchoscopy

Complications	(*N*=20) *n* (%)
No complications	17 (85)
Bleeding	2 (10)
hypoxemia	1 (5)
Deaths	0

aimed to evaluate the efficacy and safety of the lung point navigation system in the diagnosis of peripheral pulmonary lesions [3].

The right upper lobe, left lower lobe, and left upper lobe were the most often affected (30, 25, and 15%, respectively) by pulmonary lesions. Overall, 60% of patients had a single lesion, and the average dimension was 22.4-mm long by 23-mm wide. A 40% irregular margin, 30% smooth margin, 25% hypothesized margin, and 5% lobulated margin were seen in the lesions (Table 2).

There were 35.9% left upper and right upper lobe and 20% right lower lobe pulmonary lesions, with an average lesion size of 2411.3 mm [6] in the study by Kato and colleagues, which sought to assess the efficacy of VNB in increasing the diagnostic yield of peripheral pulmonary lesions, whereas Ishida *et al.* [7] found that the most prevalent locations of lesions were the right upper lobe (31%), right middle lobe (11%), right lower lobe (22.5%), left upper lobe (24.5%), and left lower lobe (25%).

Detected lesion depths from chest wall varied from 13.5 to 20.2 mm in the present investigation, with a mean ± SD of 17.2 ± 1.5 mm, whereas the mean ± SD diaphragm depth was 102.5 ± 49.5 mm, with a range of 44.7–154.2 mm. the mean depth of the detected lesion from costal margin was 17.2 mm ±1.5 SD that was ranging from 13.5 to 20.2 mm, on the other hand, the mean depth from diaphragm was 102.5 ± 49.5 SD which ranged from 44.7 to 154.2 mm. In Tachihara *et al*., [8] LN involvement was detected in 20% of cases (4/20) which was paratracheal in 10% of patients, 5% hilar, 5% hilar and subcarinal.

In this research, 65% of the pulmonary lesions were malignant in 13 patients, whereas five patients were identified as benign and two patients remained undiagnosed (25 and 10%, respectively). Ishida *et al.* [7] found that 77.3% of identified lesions were malignant, and our investigation confirmed their findings. In the Kato *et al.* [6] research, 95.7% of the lesions were found to be malignant. More than 85% of the pulmonary lesions in a recent research by Xu *et al.* [9] that coupled VNB with EBUS to improve the diagnostic yield were found to be malignant.

Adenocarcinoma was found in seven (35%) of the patients. Large-cell carcinoma, squamous and small-cell carcinoma, carcinoid tumors, fungal infections, tuberculosis, and nonspecific inflammation were all detected in 10% of the patients. A 2011 research by Oshige and colleagues found that out of 57 patients who had undergone VNB with EBUS, 35 (61.4%) had adenocarcinoma, 11 (19.3%) had squamous cell carcinoma, six (10.5%) had nonsmall-cell carcinoma, three (5.3%) had small-cell carcinoma, and 2.5% (3.5%) had metastatic lung cancer. Squamous cell cancer accounted for ~27.3% of the cases examined in the study by Tachihara *et al.* [8], adenocarcinoma accounted for ~23.07%, small-cell cancer and carcinoid tumor accounted for roughly 3.84%, and six of the cases were identified as benign.

This survey found that the average amount of time spent preparing was 5 min. The average duration to navigate lung point was 7.4 min (SD=0.8 min; range, 6–9 min), as seen in Table 4. According to a research by Asano and colleagues, the average planning time was 5 min (SD=61 s; range, 180–490 s). It took 23 min (SD=3.2 min; range, 18–35 min) to complete the test. Moreover, 5 min (SD=83 s; range, 3–8 min) is the average time spent navigating lung point (SD=83 s) [10]. The total examination duration was 16.6 min, according to the Kato *et al.* [6] research (with a range of 7.6–36.5 min). There was a 5.9-min median examination time before sample collection (range, 2.2–18.2 min).

The diagnostic yield of lung point navigation bronchoscopy in the identification of peripheral pulmonary lesions was statistically significant in the present investigation. Overall, 90% of cases investigated (18/20) were successfully diagnosed using lung point navigation, whereas 10% of cases studied (2/20) were misdiagnosed. There were 84.0% diagnostic yields for VBN-associated patients and 58.0% for those who were not, with a significant difference in the diagnostic yield between the two groups, according to the Kato and colleagues research. Conventional bronchoscopy had an accuracy rate of 78% in the identification of peripheral tumors in the Hong 2020 project, which was designed to evaluate the function of conventional bronchoscopy in the diagnosis of lung lesions. Transbronchial needle aspiration was shown to be useful in the identification of peripheral pulmonary lesions in 55% of patients in a 2011 research by Wang *et al*. [11]. Overall, 90% of cases investigated [12]. the diagnostic yield of lung point navigation bronchoscopy in the identification of peripheral pulmonary lesions was statistically significant in the present investigation. Overall, 92.9% of single pulmonary nodules were

diagnosed by CT-guided transthoracic needle biopsy in the research by Yang *et al*. [12].

The diagnostic yield was 100% for the left upper and lower lobes in this investigation, 83.33% for the right upper, and 50% for the right lower lobes. When it came to diagnosing the right upper and lower lobes, the diagnostic yield was 93.3%, whereas the diagnostic yields for the left were 83.3, 72.7, and 72.7%, respectively, in Xu *et al*. [9]. There was a 92.3% diagnostic yield in the VBN-linked group for the right lower and higher lobes, as well as 78.9 and 71.4% diagnostic yields for the left lower and upper lobes in the study by Asano *et al*. [13] (Table 5).

Bleeding and hypoxemia occurred in 5 and 10% of cases, respectively, and in the remaining 85% of cases, no bronchospasm or other complications arose as a result of the surgery, and no patients required ICU monitoring. There were no fatalities as a result of the surgery in any of the 20 patients who were followed up. The research by Asano *et al*. [13] found four VNB-related problems, including one incidence of pneumothorax, one case of temporary bradycardia, and two instances of bleeding. Tachihara *et al*. [8] and Oshige *et al*. [10] reported that lung point navigation bronchoscopy was safe and effective in all individuals. Pneumothorax occurred in 55 patients (17.7%) in the study by Yang and colleagues, which aimed to evaluate the diagnostic accuracy of CT-guided transthoracic needle biopsy for solitary pulmonary nodules, with three cases (0.9% of all patients and 5.5% of the patients with pneumothorax) requiring thoracotomy tube placement [12].

It was shown that the lung point navigation system had a highly statistically significant diagnostic yield in diagnosing peripheral pulmonary lesions using virtual bronchoscopy-guided ultrathin bronchoscopy in the present investigation.

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Conflicts of interest
There are no conflicts of interest.

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