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Original Research Article

EARLY EXPERIENCE WITH CT-GUIDED CORE BIOPSY OF LUNG TUMORS: DOES SIZE PREDICT DIAGNOSTIC ACCURACY AND COMPLICATION RATE?

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Abstract: Lung cancer remains the leading cause of cancer-related deaths and is expected to increase over the next decade. The World Health Organization and the National Comprehensive Cancer Network (NCCN) have advocated a low dose computed tomography (LDCT) scan of the chest for individuals at high risk for lung cancer[3]. With the proliferation in CT scans performed annually, there has been a corresponding increase in lung nodules identification resulting in an increase in invasive procedures to obtain a tissue diagnosis[8]. Given the increasing number of sub-centimeter lung nodules detected, this pilot study sought to determine if there is a size limit where a successful biopsy is outweighed by the potential risks, i.e. the risk of clinically significant pneumothorax.

A retrospective review of CT-guided core lung biopsies performed on 98 patients between January 2013 and January 2015 was performed. The diagnosis and pneumothorax rates were analyzed for <1 cm, 1-2 cm, 2-3 cm, 3-5cm, and >5 cm pulmonary lesions. The presence of clinically significant pneumothorax (requiring tube thoracostomy) was obtained from the patient Electronic Medical Record (EMR). The overall diagnosis and pneumothorax rates were 94.0% and 7.0% respectively. The diagnosis rate was 87.5% for <1 cm, 86.67% for 1-2 cm, 100% for 2-3 cm, 95.45% for 3-5 cm, and 100% for >5 cm pulmonary lesions. The clinically significant pneumothorax rate was 12.5% for <1 cm, 10.0% for 1-2 cm, 18.7% for 2-3 cm, 0% for 3-5 cm, and 0% for >5 cm pulmonary lesions. Our findings show a high level of diagnostic accuracy for core biopsies of lung tumors of all sizes, including sub-centimeter lung nodules while the clinically significant pneumothorax rate remained unchanged. Given this data, we believe core biopsy of small (<1cm) pulmonary nodules can be performed without a significant rise in the rate of clinically significant pneumothorax, providing for earlier detection and treatment of lung carcinoma.

Keywords: Lung cancer, Biopsy, pneumothorax.

Introduction: Lung cancer remains the leading cause of cancer related death and is expected to increase over the next decade [1]. The World Health Organization (WHO) accounts lung cancer as the world's leading cause of cancer-related death as projections of total tobacco-attributable deaths will rise from 6.4 million in 2015 to 8.3 million in 2030 [1,2]. The growing epidemic prompted screening recommendations by the United States Preventative Services Task Force (USPSTF) after the results of the National Lung Cancer Screening Trial [3,4]. The USPSTF in conjunction with the National Comprehensive Cancer Network (NCCN) launched the recommendation of a low-dose computed tomography (LDCT) scan of the chest in high risk individuals with level B evidence [3]. High-risk individuals are defined as adults aged 55 to 80 years who have a 30 pack-year smoking history and currently smoke or have quit within the past 15 years [4,5].

The annual screenings with LDCT has increased the total number of chest CT performed [6]. The increasing incidence of LDCT has shown a corresponding increase in the incidence of lung lesions detected on CT. The necessity to accurately and safely diagnose these lesions is now of utmost importance to provide optimal patient care and management. Solitary pulmonary lesions dictate further work-up ranging from additional imaging to invasive techniques such as needle biopsy and thoracotomy [7]. The NCCN supports an algorithm that involves a tissue diagnosis for pathologic examination as a minimally invasive, interventional radiology (IR) guided procedure. As imaging finds smaller and smaller lesions, management has dictated increase need for accurate and safe percutaneous biopsy of smaller and smaller lesions [5,8].

IR-guided core needle biopsy has been an established method of obtaining a tissue diagnosis in pulmonary lesions [9]. The diagnostic yield remains high, up to 90% for malignant lesions, while the morbidity and mortality remains low [9]. The most frequent complication is pneumothorax, which can usually be managed by tube thoracostomy, however fatal complications have also been reported [9]. Although rare, needle gauge, sex, age or lesion size have historically not had an affect of adverse outcomes however some studies do report a higher likelihood of pneumothorax in cohorts with a smoking history [9]. Customarily, the relationship of sub-centimeter nodules has not yielded a sufficient specimen for histopathologic analysis with regards to the potential complications of IR-guided biopsies. Small, sub-centimeter nodules have historically underwent a video assisted thoracoscopic surgery (VATS) for a tissue diagnosis as IR-guided biopsy has seen almost a thirty-percent rate of failing to diagnose a malignant pulmonary lesion for small lesions[10].

To determine the clinical implications of IR-guided biopsies of pulmonary nodules, we analyzed our single institution experience from a prospectively gathered-retrospective database. We aimed to identify the diagnostic yield of IR-guided pulmonary lesions with the primary end points of accurate tissue diagnosis quantified by lesion size as well as a clinically significant pneumothorax rate based on lesion size.

Methods: A retrospective study was performed of all patients who had CT guided core biopsy of lung lesions between January 2013 and January 2015. IRB approval was obtained and patient consent was waived. A total of 100 patients underwent CT guided core lung biopsy in that time frame (Fig 1). Patients who underwent CT guided Fine Needle Aspiration (FNA) were excluded from this study. A single lesion was biopsied in each case and the lesion size being biopsied was obtained from the corresponding radiology report. Lung lesions ranged from sub-centimeter nodules to a maximum of 11.3 cm mass.

All patients were subject to a chest radiograph up to four hours after the procedure to evaluate for a pneumothorax. If a patient experienced a clinically significant pneumothorax, defined as someone requiring a thoracostomy tube

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drainage, it was considered a complication of the procedure. The pathology report was obtained from the EMR for all the patients who underwent CT guided core lung biopsy. If the pathologist deemed the biopsy sample sufficient to make a diagnosis, the biopsy was considered a success. However, if the pathologist deemed the sample insufficient the procedure was considered non-diagnostic.

The diagnostic accuracy was measured as the success rate of the biopsies in providing the diagnosis whether benign or malignant. The complication rate was the number of clinically significant pneumothoraces. The diagnostic accuracy rates and pneumothorax rates were analyzed for pulmonary lesions at the following size thresholds: <1cm, 1-2 cm, 2-3 cm, 3-5 cm, and >5 cm.

Results: The overall diagnostic adequacy was 94.0% (n = 94) and the complication rate was 7.14% (n = 7). The diagnostic yield ranged from 100% (n = 24) for >5 cm masses to 87.5% (n = 8) for <1 cm pulmonary nodules (Fig 2). The diagnostic yield was calculated by taking the diagnostic biopsies as a percentage of total biopsied specimens in that corresponding group. A total of 6 patients who had CT guided core biopsy for nodules and masses >1 cm had pathology results that were non-diagnostic. For <1 cm nodule, only 1 patient had a non diagnostic result.

The complication rate was 12.5% (n = 1) for <1 cm nodules, 10.0% (n = 3) for 2-3 cm nodules, 18.7% (n = 3) for 2-3 cm nodules, and 0% for 3-5 cm and >5 cm masses (Fig 1 and 2). A total of 7 patients experienced a clinically significant pneumothorax requiring thoracostomy tube drainage. For <1 cm nodules, only 1 patient experienced a pneumothorax requiring thoracostomy tube drainage

Data were analyzed using the Pearsons Chi-square test[12]. The level of significance was set at P value of less than 0.05. Analysis showed the diagnostic yield differed among groups with a P value of 0.1921 (df = 4). The incidence of a clinically significant pneumothorax differed among groups with a P value of 0.1056 (df = 4).

Discussion: There has been a recent increase in utilization of the CT of the chest to screen for pulmonary nodules[3]. CT guided core biopsy continues to have an increasing role in diagnosis. The most clinically significant complication is usually a pneumothorax.

In our retrospective study, our experience with CT guided core biopsy of pulmonary lesions shows that the overall diagnostic yield is 94.0% which is comparable to the literature average of 80-97%. The overall clinically significant complication rate in our analysis was 7.0% compared to the literature average of 9-54%. Subdividing the pulmonary lesions into different size threshold shows that the diagnostic yield does not differ significantly between the groups (P value of 0.1921) and neither does the complication rate (P value of 0.1056). For <1 cm nodules, the diagnostic yield was 87.5 % and the complication rate was 12.5%. In a series of CT guided biopsy of lung lesions, Tsukada et el. reported a diagnostic accuracy of 66.7% for lesion 6-10mm[11]. Our results show that small pulmonary lesions including sub-centimeter nodules can be biopsied without increasing the risk of major complications, while maintaining the same level of diagnostic yield. This has great potential for patient care as lung carcinomas can be diagnosed at an earlier stage, which may impact the surgical approach and systemic treatment[8].

There were several limitations to our study. We did not include a small pneumothorax into the complication group as these resolved without any clinical intervention. Different operator method may also influence the diagnostic yield. We limited our evaluation to the lesion size, and we did not take into consideration the depth of the lesion from the pleural surface, the size of the biopsy needle, or the number of passes it took to obtain the specimen. All these variables may affect the diagnostic yield to a certain degree; however, it was not the scope of our paper.

Our study does prove that small pulmonary lesions including the sub-centimeter nodules can be biopsied safely without a statistically significant rise in the complication rate, while keeping the diagnostic yield at an acceptable level.

Supplemental Data

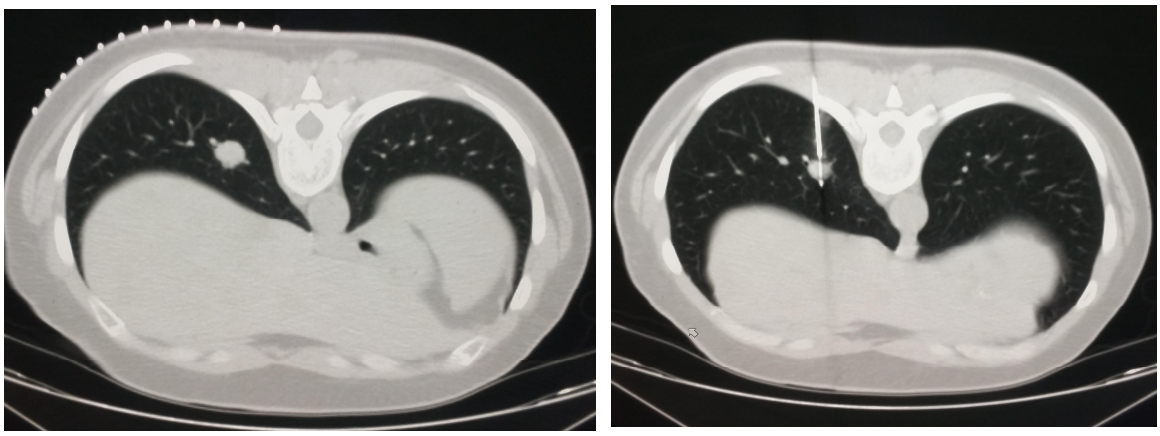

Figure 1: Example of a CT guided core lung biopsy in a patient with left lower lobe nodule. A, CT scan shows a 1.3mm nodule in the left lower lobe with a marker grid on the skin B, CT obtained during the biopsy shows the needed traversing the nodule to obtain a specimen.

Figure 2: Diagnostic yield versus complication rate in 100 patients that underwent CT guided core biopsy of lung nodules

Diagnostic yield				
Nodule size	**Patients**	**Diagnosis**	**Non-diagnostic**	**Diagnostic yield**
<1 cm	8	7	1	87.50%
1-2 cm	30	26	4	86.67%
2-3 cm	16	16	0	100.00%
3-5 cm	22	21	1	95.45%
>5 cm	24	24	0	100%
Total	100	94	6	94.00%
Complications (Pneumo-thorax with chest tube)				
Nodule size	**Patients**	**Pneumothorax with chest tube**		**Complication rate**
<1 cm	8	1		12.50%
1-2 cm	30	3		10.00%
2-3 cm	16	3		18.70%
3-5 cm	22	0		0.00%
>5 cm	24	0		0.00%
Total	100	7		7.00%

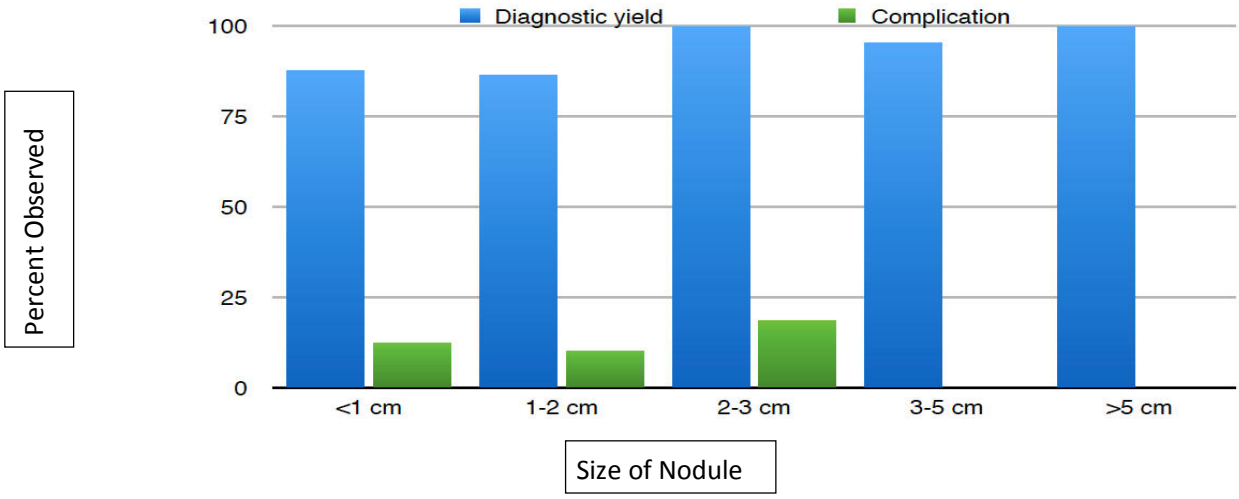

Figure 3: Comparing the diagnostic yield versus complication rate among different groups

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