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Clinical Study

Needle Gauge and Cytological Yield in CT-Guided Lung Biopsy

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Rationale and Objectives. The aim of this study is to determine the effect of needle size on the diagnostic yield and complication rate of lung nodule biopsy. *Materials and Methods*. A total of 209 patients are included in a retrospective study. All patients underwent a needle lung biopsy under computer-tomography-guided guidance. Multiple different needle gauges are used in this study. *Results*. We found no correlation between the gauge of the needle and the incidence of complications or diagnostic yield associated with lung nodule biopsy. However, there was a statistically significant difference in the number of needle passes and the gauge of the needle ($P < .01$). *Conclusion*. Using a larger gauge needle does not correlate with an increase in complication rate. However, there is a statically significant decrease in the number of needle passes using a larger gauge needle. While the diagnostic yield comparing small gauge needle and large gauge needle was not statistically different, this lack of difference in yield could be related to the difference in number of passes. The use of larger needle is likely to decrease number of passes, thereby resulting in decreased procedure times.

1. Introduction

The lung and the bronchus constitute a site with the second highest incidence rate of invasive cancer in males and females; furthermore, cancer involving the lung and bronchus is the leading cause of cancer deaths in the USA [1]. Accurate diagnosis of pulmonary lesions is vital for detecting lung cancer because of its high mortality. Percutaneous CT-guided needle lung biopsy has a high diagnostic accuracy and is a well-established procedure for obtaining a cytological evaluation of pulmonary nodules [2, 3]. Factors affecting diagnostic accuracy are lesion size, immediate on-site sample evaluation by a cytologist, and technique, including type of biopsy device [4–10]. A previous study has shown core biopsies to be a more accurate method of tissue sampling without increasing risk of complications when compared to fine-needle aspiration [11]. The major complication of percutaneous lung biopsy is pneumothorax, which has been reported to occur between 9% and 44% [5, 11–14]. Reported risk factors for pnuemothorax are lesion depth, angle of needle path, and the number of needle passes. A short depth and a needle path that is near perpendicular to the pleura have been associated with reduced incidence of pneumothorax [15]. Other procedural factors such as increasing the number of needle passes or the use of larger needle sizes are not associated with an increase in the rate of pneumothorax or chest tube placement [3, 16, 17]. When analyzing diagnostic yield and complication rate of CT-guided lung biopsies, studies have reported data using coaxial cutting needle systems or fine-needle aspiration. The aim of this study is to determine the effect of needle size on the cytological yield and the complication rate.

2. Materials and Methods

Two hundred and ninety-two adult patients were referred for CT-guided lung biopsies between 1/1/03 and 7/15/07. Patients who underwent core needle biopsy or whose data was incomplete were excluded. The remaining 209 patients were included in this study. WinSTAT for Microsoft Excel (version 2006.1) was employed for statistical analysis of the data. Correlative statistics were performed using a Spearman's rank correlations. The average age of the study subjects was 65.7 ± 13 years, and the cohort consisted of 119

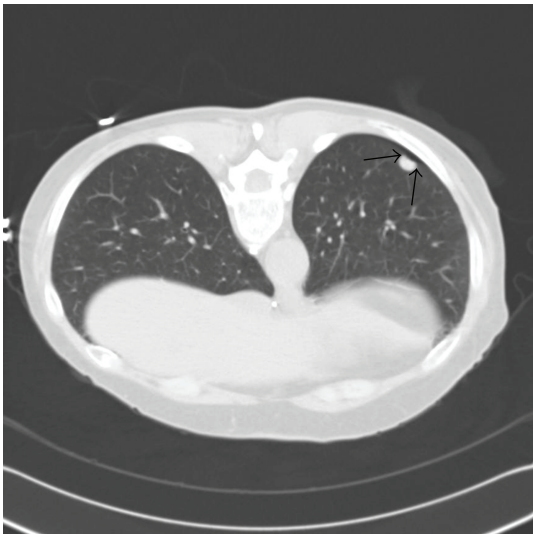

Figure 1: Small anterior pneumothorax seen after right lung biopsy.

Table 1: Correlations between end points and study variables.

Parameters		Correlation (r^2)	Significance (P value)
Gauge	Complications	0.0036	.18
	Chest tube	0.0002	.41
	Number of passes	0.17	<.01
	Yield	$9.2 \times 10 - 9$	.49
Passes	Complications	0.00014	.43
	Chest tube	000729	.34

Table 2: Frequency of the number of passes performed using different needle gauges.

		Number of passes					
	Needle gauge	1	2	3	4	5	6
Frequency of Passes	18 gauge	50	28	8	2	0	0
	19.5 gauge	10	4	2	1	0	0
	21 gauge	21	39	23	16	0	5

males and 90 females. Using similar technique, three separate experienced radiologists performed lung biopsies; all needle gauges were determined by the radiologist performing the procedure at the time of the biopsy.

Patients were placed on the CT table in a prone, supine, or decubitus position. A CT scan of the thorax was performed. A needle path that would avoid ribs and vascular structures was planned. Each needle path was chosen to have the shortest possible depth and the most perpendicular angle to the pleura. The skin entry site was marked using a laser grid system. The entry site was cleaned and prepped in the usual sterile fashion. Local anesthesia was administered using 1% lidocaine. An 18, a 19.5, or a 21 gauge Percucut biopsy needle (E-Z-EM. Inc, Lake Success/NY/USA) was advanced under CT guidance to the edge of the lesion. Breath-holding technique was employed while crossing the pleura. After each biopsy, the sample was handed to the on-site cytologist for evaluation of sample yield. Repeat passes were performed as needed.

A positive cytology result was considered for any cytology that was definitively diagnostic.That is, malignant, non-small-cell lung carcinoma, squamous carcinoma, or adenocarcinoma were considered positive result. A non-diagnostic results was any report which did not have these phrases; for example, highly suspicious, atypical, and not able to exclude carcinoma were all considered nondiagnostic.

A postprocedure CT scan and chest radiograph were performed on all patients. Small pneumothoraces were managed conservatively with monitoring of vital signs and follow-up chest X-rays. Pneumothoraces that caused respiratory distress were managed by placement of a pleural catheter and admission to an inpatient service.

In this retrospective study, each biopsy procedure was reviewed on our IntegradWeb picture archiving and communication system workstation (GE Healthcare, Waukesha/Wis/USA) and the radiology information system. The size of the lesion, the angle of inclination of the needle, the number of passes through the pleura and the gauge of the needle were determined. The distance of the lesion from the pleura, was determined by using the actual path of the needle rather than the shortest possible route. Approval for this retrospective study was obtained from the Institutional Review Board.

3. Results

Of the 209 patients, 88 biopsies (42.1%) were performed with an 18 gauge needle, 17 biopsies (8.6%) were performed with a 19.5 gauge needle, and 104 biopsies (49.7%) were performed with a 21 gauge needle. A pneumothorax was found in 30.1% of patients. Most of these were small and did not require an intervention. Figure 1 illustrates a typical small pneumothorax which was managed conservatively. The rate of chest tube placement was 4.6% (Table 1). The average depth of the lesions was 1.7 cm (±1.7 cm 95% CI), with minimum 0 cm and a maximum of 8 cm. The average size of the lesions biopsied in this cohort was 3.1 cm (±2.1 cm 95% CI), with minimum of size of 0.8 cm and a maximum of 16 cm. The mean angle of inclination was 71.2 degrees (±15 degrees 95% CI). There was no significant correlation between needle's gauge and number of complications (P = .18). Fewer passes were performed with an 18 gauge needle to a 21 gauge needle, with 1.8 ± 0.14 (95% confidence interval) passes, and 2.5 ± 0.3 (95% confidence interval) passes, respectively (Table 2). The cytology reports revealed malignancy in 171 cases (81.8%). An additional 18 cases were definitively diagnosed as benign or showed lack of growth or completely regressed after being followed up for at least one year. This increases the diagnostic cytological yield to 189 cases (90.4%). Twenty cases were nondiagnostic at cytology; of these, 15 were later diagnosed as non-small-cell lung carcinoma, 4 as lymphoma, and 1 as a typical carcinoid. The remaining three lesions were metastatic breast cancers, pancreatic carcinoma, and a plasmacytoma. There were no known false positive cases (Table 3).

Table 3: Cytological findings.

Cytology results		
Adenocarcinoma	52	
Squamous	34	
Non-small-cell: not otherwise specified (NOS)	85	
Nondiagnostic	18	At followup were stable or resolved.
	20	12 Non-small-cell lung ca (NOS) 4 Lymphoma 1 Carcinoid 1 Metastatic breast cancer 1 Metastatic pancreatic carcinoma 1 plasmcytoma

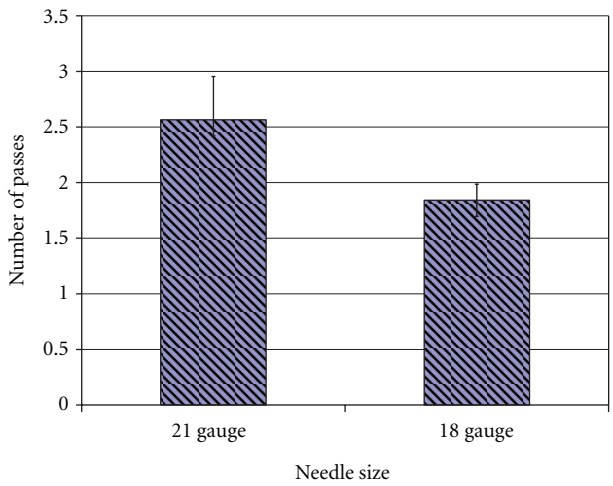

Figure 2: Comparison between number of pleural passes and the gauge of the needle (error bars 95% CI).

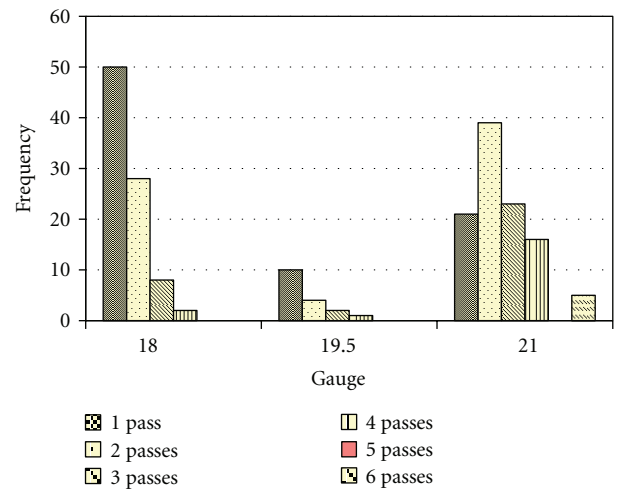

Figure 3: Number of pleural passes for each individual patient compared with needle gauge.

There was no significant correlation between needle's gauge and number of complications ($P = .18$). Fewer passes were performed with an 18 gauge needle to a 21 gauge needle, with 1.8 ± 0.14 (95% confidence interval) passes, and 2.5 ± 0.3 (95% confidence interval) passes, respectively. This difference was statistically significant by a Spearman's rank correlation with a $P < .01$, see Figure 2. A single pass was required in 56.8% of biopsies when an 18 gauge needle was used. In contrast, only 19.6% of biopsies were performed with one pass using a 21 gauge needle, see Figure 3. There was no significant difference between the needle gauge and the cytological yield ($P = .49$). There was no correlation between the number of passes and the complication rate ($r^2 = 0.16$).

4. Discussion

The sensitivity of lung biopsy in this study was 90.4%, which is comparable to other studies [3–5, 11]. This high sensitivity adds support to the efficacy of CT-guided needle biopsy for evaluation of pulmonary nodules in the presence of on-site cytologist. One of the major complications associated with lung biopsy is pneumothorax. The frequency of pneumothorax (30.1%) and chest tube placement (4.6%) in our study conforms to ranges reported by other studies [5, 11, 13]. Prior studies have suggested that many factors influence the diagnostic yield of lung biopsies. This study did not find correlation between the depth of the lesion, the size of the lesion, the angle of inclination, and the gauge of the needle with the diagnostic yield. There are many potential reasons for these findings; one is a population bias. In this cohort, most lesions were larger than one centimeter. Ng et al. [18] reported a decrease in pathological yield in lesions less than one centimeter. No association between the needle's gauge and the incidence of complications was found in this study.

Comparing the number of needle passes with the gauge of the needle, there is a significant difference. The majority of cases performed with an 18 gauge needle required only a single pass for obtaining a cytological diagnosis while less than a 20% of the cases performed with a 21 gauge needle were performed with a single pass. The large gauge needle resulted in a diagnostic cytology with fewer passes compared to smaller gauge needle. We reason that this lower number of passes would likely decrease procedure time without

compromising the yield or the safety of the procedure based on our results, and, therefore, the use of larger gauge needle is supported. There are multiple studies that have shown core biopsies to be superior to fine-needle aspiration biopsies [2, 10, 11]. The exact reason for the superior rate of yield with core biopsy has not been determined. We speculate that the gauge of the core needles—typically 17 to 19 gauges—could be one of the reasons for superior cytological yield. This would explain the finding of this study. Additionally, core biopsies allow multiple passes to be performed without additional pleural transgressions.

The conclusions drawn from the present study are limited by a number of factors. One limiting factor is the population sample analyzed in this study. Of the 292 patients who were referred for lung biopsy, 83 were excluded due to incomplete records or having a core biopsy performed; this resulted in a smaller population size and possibly a skewed sample. Core biopsies were excluded to avoid bias on the part of the cytologist from knowledge of the surgical pathology. Patients included in this study were more likely to have a lung malignancy as observed by the small number of benign diagnoses in our study. There may have been false-positive malignant diagnoses if the cohort included more benign lesions. In addition, this was a retrospective study and, therefore, the radiologist performing the procedure may have selected the needle gauge based on characteristics of the lesion rather than in a systematic manner, which would lead to compounding factors. A randomized study with a larger sample size will be more accurate for assessing the association of needle gauge with the number of passes to achieve similar yield rate. Finally, the gauge of the needle used for each procedure was not determined in a rigid manner, thus introducing a potential bias.

Our data showed that the use of 18 gauge needle for lung biopsy is associated with fewer passes, similar complication rate, and equivalent diagnostic yield when compared to smaller gauge needle. We believe that our data supports the use of larger gauge needle for lung nodule biopsy as this practice would decrease procedure time.

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References

[1] U.S. Cancer Statistics Working Group, "United States cancer statistics: 1999–2005 incidence and mortality," Web-Based Report, Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute, Atlanta, Ga, USA, 2009, http://www.cdc.gov/uscs.

[2] R. Lourenco, R. Camacho, M. J. Barata, D. Canario, A. Gaspar, and C. Cyrne, "CT-guided percutaneous transthoracic biopsy in the evaluation of undetermined pulmonary lesions," *Revista Portuguesa de Pneumologia*, vol. 12, no. 5, pp. 503–524, 2006.

[3] J. L. Swischuk, F. Castaneda, J. C. Patel et al., "Percutaneous transthoracic needle biopsy of the lung: review of 612 lesions," *Journal of Vascular and Interventional Radiology*, vol. 9, no. 2, pp. 347–352, 1998.

[4] M. Montaudon, V. Latrabe, A. Pariente, O. Corneloup, H. Bergueret, and F. Laurent, "Factors influencing accuracy of CT-guided percutaneous biopsies of pulmonary lesions," *European Radiology*, vol. 14, no. 7, pp. 1234–1240, 2004.

[5] Y. Ohno, H. Hatabu, D. Takenaka et al., "CT-guided transthoracic needle aspiration biopsy of small (< or = 20 mm) solitary pulmonary nodules," *American Journal of Roentgenology*, vol. 180, no. 6, pp. 1665–1669, 2003.

[6] N. Yoshimura, K. Takeda, H. Tada et al., "The factors determining diagnostic accuracy in CT-guided percutaneous needle biopsy of small pulmonary nodules," *Nihon Kokyuki Gakkai Zasshi*, vol. 40, no. 2, pp. 101–105, 2002.

[7] F. Laurent, V. Latrabe, B. Vergier, M. Montaudon, J. M. Vernejoux, and J. Dubrez, "CT-guided transthoracic needle biopsy of pulmonary nodules smaller than 20 mm: results with an automated 20-gauge coaxial cutting needle," *Clinical Radiology*, vol. 55, no. 4, pp. 281–287, 2000.

[8] L. Santambrogio, M. Nosotti, N. Bellaviti, G. Pavoni, F. Radice, and V. Caputo, "CT-guided fine-needle aspiration cytology of solitary pulmonary nodules: a prospective, randomized study of immediate cytologic evaluation," *Chest*, vol. 112, no. 2, pp. 423–425, 1997.

[9] E. Mazza, C. Maddau, A. Ricciardi, M. Falchini, M. Matucci, and T. Ciarpallini, "On-site evaluation of percutaneous CT-guided fine needle aspiration of pulmonary lesions. A study of 321 cases," *La Radiologia Medica*, vol. 110, no. 3, pp. 141–148, 2005.

[10] J. S. Moulton and P. T. Moore, "Coaxial percutaneous biopsy technique with automated biopsy devices: value in improving accuracy and negative predictive value," *Radiology*, vol. 186, no. 2, pp. 515–522, 1993.

[11] J. M. Anderson, J. Murchison, and D. Patel, "CT-guided lung biopsy: factors influencing diagnostic yield and complication rate," *Clinical Radiology*, vol. 58, no. 10, pp. 791–797, 2003.

[12] L. B. Haramati, "CT-guided automated needle biopsy of the chest," *American Journal of Roentgenology*, vol. 165, no. 1, pp. 53–55, 1995.

[13] E. A. Kazerooni, F. T. Lim, A. Mikhail, and F. J. Martinez, "Risk of pneumothorax in CT-guided transthoracic needle aspiration biopsy of the lung," *Radiology*, vol. 198, no. 2, pp. 371–375, 1996.

[14] G. M. Stevens and R. J. Jackman, "Outpatient needle biopsy of the lung: its safety and utility," *Radiology*, vol. 151, no. 2, pp. 301–304, 1984.

[15] H. Saji, H. Nakamura, T. Tsuchida et al., "The incidence and the risk of pneumothorax and chest tube placement after percutaneous CT-guided lung biopsy: the angle of the needle trajectory is a novel predictor," *Chest*, vol. 121, no. 5, pp. 1521–1526, 2002.

[16] A. Fukushima, K. Ashizawa, N. Aso et al., "CT-guided needle biopsy of the lung: factors affecting risk of complications," *Nippon Igaku Hoshasen Gakkai Zasshi*, vol. 61, no. 3, pp. 96–99, 2001.

[17] A. M. Priola, S. Novello, and S. M. Priola, "Factors effecting risk of pneumothorax (PNX) in CT-guided transthoracic needle biopsy of lung lesions: results of 708 consecutive procedures: C2-02," *Journal of Thoracic Oncology*, vol. 2, no. 8, p. S362, 2007.

[18] Y. L. Ng, D. Patsios, H. Roberts et al., "CT-guided percutaneous fine-needle aspiration biopsy of pulmonary nodules measuring 10 mm or less," *Clinical Radiology*, vol. 63, no. 3, pp. 272–277, 2008.