Diagnostic accuracy and complication rate of CT-guided fine needle aspiration biopsy of lung lesions: A study based on the experience of the cytopathologist

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Background: CT-guided transthoracic needle biopsy is a well-established technique for the diagnosis of focal lung lesions. Fine needle aspiration biopsy (FNAB) requires the presence of a cytopathologist on-site to assess the adequacy of samples. For this reason FNAB is less and less used, and core biopsy is the first-line procedure when an experienced cytopathologist is not immediately available.

Purpose: To evaluate the accuracy and complication rate of CT-guided FNAB of lung lesions according to the experience of the cytopathologist on-site.

Material and Methods: A total of 321 consecutive biopsies were considered. Immediate cytological assessment was performed by an experienced cytopathologist for the first 165 procedures (group A) and by two training pathologists for the remaining 156 biopsies (group B). At the time of FNAB the pathologist assigned a semiquantitative score (0 – 3) to each specimen to assess its diagnostic quality. All variables between the two groups were analyzed by chi-square and Student’s t test. A P value <0.05 was considered statistically significant.

Results: For all procedures, overall diagnostic accuracy was 80% for cytology alone, with no statistical difference between the two groups for diagnostic accuracy and sample score assigned. In all, 75% of the cytological samples (75% group A, 74% group B) obtained a higher score with a specific diagnosis of histotype. A post biopsy pneumothorax was detected in 27% of biopsies (25% group A, 28% group B). Thirteen patients (4.0%) required chest tube insertion for treatment. For all cases, the pneumothorax rate was significantly affected by the number of samples obtained (P=0.02), but not by the pleural punctures (P=0.15). There was no statistically significant difference between the two groups concerning the number of needle passes and complication rate (P>0.05).

Conclusion: The efficacy and safety of CT-guided FNAB is not significantly affected by the training level of the cytopathologist on-site. Moreover, the number of specimens obtained for each procedure is a risk factor for pneumothorax.

Key words: Pneumothorax; diagnostic quality

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Computed tomography (CT)-guided percutaneous fine needle aspiration biopsy (FNAB) of lung lesions is a well-established technique for the cytologic diagnosis of peripheral malignant lung lesions, with a reported diagnostic accuracy rate of >93% and a sensitivity rate of >95% (1, 2). However, its diagnostic sensitivity rate in benign lung diseases is reported to be <50% in most series (3). Aside from pneumothorax (16.0–44.6%) and chest tube insertion (2.5–17.4%), reported complications are uncommon for image-guided FNAB (2, 4, 5). In comparison with FNAB, cutting needle biopsy (CB) achieves better diagnostic accuracy for benign lung lesions (71–97%) and comparable high diagnostic accuracy for malignant lung tumors (88–95%) (3, 6, 7), with similar low risk of pneumothorax and without the need for an on-site cytopathologist (2, 3, 7, 8). It is also the most reliable percutaneous lung biopsy technique when a focal lung lesion is presumably benign according to the results of an imaging study. Therefore, it has the potential to replace FNAB as the method of choice for percutaneous lung needle biopsy (8). Indeed, one main
limitation of aspiration biopsies is the operator’s inability to assess the adequacy of the sample visually (9). The presence of a cytopathologist at the time of FNAB, to confirm that diagnostic material has been obtained, has been shown to improve diagnostic yield because immediate cytologic assessment of a specimen can lead to a decision to perform another biopsy without delay (9, 10). If this resource is not available, it has been suggested that core biopsies should be obtained routinely (11).

Many studies have been published that assess the value of immediate cytological examination during FNAB (9–12) but, to the best of our knowledge, the importance of the cytopathologist’s experience has not yet been addressed in the English literature. The aim of the present retrospective study was to compare the presence of an experienced cytopathologist versus a training cytopathologist with regard to the number of needle passes, accuracy, and complication rate.

**Material and Methods**

**Study population, biopsy procedure, and cytological assessment**

From April 2005 to February 2007, 321 consecutive percutaneous CT-guided FNABs were performed in 316 patients with a CT-documented pulmonary nodule or mass lesion. In all patients a definitive final diagnosis was obtained. The study population included 229 men and 92 women aged 29–87 years (mean age 65.8 years, median age 68 years, SD 2.1 cm, median 3.1 cm).

Ninety-three lesions (29%) abutted the pleural surface; the mean thickness of aerated lung traversed by the needle in the remaining 228 cases was 2.7 cm (range 0.2–7.5 cm). In 81 patients a surgical resection was subsequently performed, while 240 patients were non-candidates for surgery due to advanced age, impaired cardiopulmonary function, or late stage disease. A brief history and written informed consent were obtained from each patient before each biopsy. No institutional review board approval was required.

Commercially available spiral CT scanners (2-row CT, Elschint CT-Twin, HeliCAT II, Haifa, Israel; 6-row CT, PHILIPS Brilliance, MX8000IDT, Philips Medical Systems, Eindhoven, The Netherlands) were used for all biopsies. The patients were instructed to abstain from moving, coughing, talking, or deep breathing during the procedure and the 4-h post-procedural period. The procedure was performed with the patient in a prone, supine, or lateral decubitus position, depending on the location of the lesion. In most situations, patient positioning was based on the shortest distance from the lesion to the visceral pleural surface. Images were obtained through the region of interest by using a section thickness of 3–5 mm and were displayed with a lung window setting (center –600 HU, width 1550 HU). FNAB was performed directly with a 21- or 20-gauge aspirating needle, 9 or 15 cm in length, with use of single-pass needle system (FNAB-Chiba; Medax, Mantova, Italy). Co-axial procedures were performed with a 17-gauge outer needle and an 18-gauge inner automated cutting needle (BioPince™ full core biopsy instrument and co-axial introducer needle; InterV-MDTC, Gainesville, Fla., USA). Our initial approach in pulmonary nodules routinely uses a Chiba fine needle (non-coaxial FNAB), except in cases of a subsequent attempt after previous inconclusive procedures. For repeat procedures, we consider the possibility of using a cutting needle. Regarding FNAB, non-coaxial technique is preferred and this approach results in limited cost savings (13). After needle insertion, accurate localization of the needle tip – preferably near the margin of the lesion, to avoid necrotic areas – was confirmed with sequential CT images. Samples were then obtained using an aspiration technique. Also, 18-gauge core samples obtained with a full core biopsy needle were obtained from 35 patients in whom preliminary cytologic results were inconclusive and core sampling was deemed safe, but these samples were excluded from this study and from calculation of diagnostic accuracy. Pleural effusions, fissures, and bullae were avoided during biopsy if possible.

Immediate cytological assessment was performed by a pathologist on-site for all biopsies: an experienced attending cytopathologist, who had 15 years of experience in lung cytology (about 350–400 cytological samples of lung pathology managed per year), was available for the first 165 procedures (group A); two training pathologists (fellows with at least 1 year of experience in lung cytology) were alternatively present for the remaining 156 biopsies (group B). All aspirates obtained were immediately fixed on sterile glass slides using a spray preparation with polyethylene glycol base and stained with methylene blue by the cytopathologist, who used a light microscope located in the same room to assess, within a few minutes, whether the sample was adequate (quantity and quality of material sufficient for diagnosis). If possible, additional aspirates were obtained when specimens were not sufficient for diagnosis. When the samples had a high cellularity, they were defined as adequate. Samples were considered inadequate when cellularity was poor or absent, and when there was necrosis or blood-stained material (12). At the time of FNAB the pathologist assigned a semiquantitative score for each specimen: 0 for bloody sample without other cells; 1 for non-specific benign...
or inflammatory cells; 2 for malignant cells without histotype characterization, but the distinction in small cell/non-small cell lung carcinoma; 3 for established benign or malignant histotype. Samples with score 0–1 were considered non-diagnostic and therefore classified as false negatives in relation to the final diagnosis. Samples with score 2–3 were considered adequate. All fixed cytologic preparations, including decolorized methylene blue-stained material, were stained by the Papanicolaou technique to obtain the definitive cytologic diagnosis.

Post procedure imaging and care
The presence of pneumothorax and/or pulmonary bleeding was assessed by evaluation of CT images, obtained both during and immediately after the biopsy. After needle removal, patients were placed on a stretcher for 3 h in the puncture side-down position and observed in the Radiology Department. At the end of this period a postero-anterior expiratory chest radiograph was obtained, with the patient in the erect position. The procedure was complicated by pneumothorax when pneumothorax was seen on either the follow-up CT scan obtained immediately after biopsy or on the delayed chest radiograph. The placement of a chest catheter or tube was considered in the event a patient with a small non-enlarging pneumothorax became symptomatic or a large pneumothorax was found. The frequency of pneumothorax, chest tube placement, and other complications was recorded.

Data collection and statistical analysis
Medical charts, pathologic reports, and radiological data on all CT-guided transthoracic FNAB were reviewed. Final diagnoses were based on the surgical outcomes or the imaging data and clinical radiological follow-up for a period of at least 28 months after biopsy (response to first-line chemotherapy or antibiotic treatment based on biopsy result, unchanged imaging findings without treatment; follow-up range 28–50 months). Procedures in which the tissue specimens were deemed nondiagnostic (n = 64; 32 group A, 32 group B), even after additional aspirates (n = 93; 48 group A, 45 group B), were not excluded from the calculation of sensitivity, specificity, and diagnostic accuracy, and were considered malignant or benign false negative results according to the final diagnosis. Factors related to patient, lesion, and procedure were recorded (age, sex, lesion location, lesion size, lesion depth, number of pleural punctures, number of needle passes in the lesion, and training level of cytopathologist on-site). Lesion size was determined on the basis of the average lesion diameter in two axial planes measured on lung window setting. Lesion depth was the amount of aerated lung traversed by the needle from the surface of the pleura to the proximal margin of the target lesion. The number of pleural punctures or pleural passes was considered the number of passes made across the pleural surface with the needle. The number of needle passes in the lesion was considered the number of aspirates and cutting specimens obtained for each procedure. All these data were recorded prospectively in the biopsy reports by radiologists performing the needle biopsies.

Statistical analysis was performed using commercial software (Statistica 6.0 for Windows, StatSoft Inc., Tulsa, Okla., USA) on a personal computer. We compared the results between the two groups according to sample score (0–3), diagnostic accuracy, and complication rate. Fisher’s exact test or χ² statistic and unpaired Student’s t test were used to assess the statistical significance of the differences between the two groups for categorized and continuous variables, respectively. A probability value <0.05 was considered to indicate statistical significance.

Results
In all, 321 biopsies were performed in 316 patients. In five patients, the same lesion was biopsied twice at different times (three in group A, two in group B). All procedures were performed by FNAB, while in a minority of cases (35/321, 11%; 19 group A, 16 group B) a subsequent CB was requested, because of the inadequate material obtained by previous FNAB. For all procedures dealing with the use of FNAB, 75% of cytological samples (239/321; 124 group A, 115 group B) obtained higher score (92% malignancies), while in 80% of FNABs (257/321; 133 group A, 124 group B) samples were considered adequate for diagnosis (score 2–3) (Table 1). A score of 0–1 (non-diagnostic) was assigned in 64 cases (32 for each group). There was no statistical difference between group A and group B regarding scores assigned by the experienced pathologist versus training cytopathologists (74 vs 75%, 6 vs 6%, 10 vs 10%, and 11 vs 9%, respectively.

Table 1. Sample scores assigned by the cytopathologist on-site for the two groups A and B, and for all procedures

<table>
<thead>
<tr>
<th>FNAB</th>
<th>n</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A+B</td>
<td>321</td>
<td>239</td>
<td>18</td>
<td>5.6</td>
<td>32</td>
</tr>
<tr>
<td>Group A</td>
<td>165</td>
<td>124</td>
<td>9.5</td>
<td>17</td>
<td>10.3</td>
</tr>
<tr>
<td>Group B</td>
<td>156</td>
<td>115</td>
<td>9.5</td>
<td>15</td>
<td>9.6</td>
</tr>
</tbody>
</table>

n, number of samples. Mean score ± SD: A = 2.47 ± 1.00; B = 2.42 ± 1.05; P = 0.65 (Student’s t test).
for scores from 3 to 0 in group A and B. Diagnostic samples: group A 133, group B 124; inadequate samples: group A 32, group B 32; \( P=0.46 \), Fisher’s exact test (Table 1). Regarding FNAB, both groups obtained similar results in terms of overall diagnostic accuracy (group A, 80.6%; group B, 79.5%). A total of 64 aspirations were considered inadequate for diagnosis by the on-site cytopathologist. In 35 cases a subsequent CB test) (Table 1). Regarding FNAB, both groups obtained similar results in terms of overall diagnostic accuracy (group A, 80.6%; group B, 79.5%). A total of 64 aspirations were considered inadequate for diagnosis by the on-site cytopathologist. In 35 cases a subsequent CB was performed. In the remaining patients further passes were not pursued for clinical reasons (patients with hemoptysis or pneumothorax that was enlarging or accompanied by symptoms of shortness of breath and/or pain). The definitive diagnosis was malignant in 262 patients (81.6%) and benign in 59 (18.4%), with no significant difference in number of benign and malignant diagnoses between the two groups. A definitive FNAB specific benign diagnosis could be obtained in 29 of 59 biopsies (49%). All these cases were correctly diagnosed as benign. For the diagnosis of malignancy, the number of true positive, true negative, false positive, and false negative cases, sensitivity, specificity, positive and negative predictive values of cytology alone was slightly higher in group B, there was no statistically significant difference between the two groups (Table 1). Furthermore, the two groups were similar in age, lesion diameter, lesion depth, and number of fine needle aspirations obtained and pleural punctures performed (Table 4). The mean number of fine needle aspiration and cutting specimens obtained was 1.30 in group A and 1.31 in group B. Although the number of samples was slightly higher in group B, there was no statistically significant difference between the two groups (\( P>0.05 \), Student’s \( t \) test). Furthermore, no significant differences in pneumothorax rate (25.4% group A, 28.2% group B) and number of severe complications (chest

<table>
<thead>
<tr>
<th>Complication</th>
<th>Minor (%)</th>
<th>Major (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumothorax</td>
<td>73 (22.8)</td>
<td>13 (4.0)</td>
</tr>
<tr>
<td>Pulmonary hemorrhage</td>
<td>92 (28.7)</td>
<td>2 (0.6)*</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>9 (2.8)</td>
<td>2 (0.6)*</td>
</tr>
<tr>
<td>Subcutaneous emphysema</td>
<td>16 (5.0)</td>
<td>–</td>
</tr>
<tr>
<td>Vasovagal syndrome</td>
<td>16 (5.0)</td>
<td>2 (0.6)</td>
</tr>
</tbody>
</table>

\( n \), number of patients. Grade: minor, no treatment required; major, requiring medical/surgical treatment and/or hospitalization. All complications developed within 4 h after biopsy.

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Table 2. Performance of cytology in the diagnosis of malignancy for all procedures

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>True positive</th>
<th>False positive</th>
<th>False negative</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cytology (321*)</td>
<td>227</td>
<td>29</td>
<td>1</td>
<td>86.7</td>
<td>98.3</td>
<td>99.6</td>
<td>45.3</td>
</tr>
</tbody>
</table>

Final diagnoses were the result of analysis of outcome of surgery, imaging, and clinical follow-up for at least 28 months. PPV, positive predictive value; NPV, negative predictive value. Overall accuracy rate [number of lung lesions accurately diagnosed = (true positive + true negative)/total number of cases]; cytology = \( (227+29)/321 \), 79.8%.

*Twenty-nine samples from cytology that demonstrated only blood, fat or normal lung tissue (benign lesions at final diagnosis) were not considered true negative cases because of the impossibility of reaching a definitive diagnosis at biopsy. In any case, they were not excluded from this study and from calculation of overall diagnostic accuracy.
Table 5. Relationship between the number of passes in the lesion and the incidence of pneumothorax

<table>
<thead>
<tr>
<th>No. of passes</th>
<th>Pneumothorax (n=86)</th>
<th>No pneumothorax (n=235)</th>
<th>Total (n=321)</th>
<th>Pneumothorax rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 pass</td>
<td>54</td>
<td>174</td>
<td>228</td>
<td>23.7</td>
</tr>
<tr>
<td>2 passes</td>
<td>29</td>
<td>60</td>
<td>89</td>
<td>32.6</td>
</tr>
<tr>
<td>3 passes</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>75</td>
</tr>
<tr>
<td>Mean value</td>
<td>1.41</td>
<td>1.26</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Table 6. Correlation of pneumothorax rate with number of pleural punctures

<table>
<thead>
<tr>
<th>No. of pleural punctures</th>
<th>Pneumothorax (n=86)</th>
<th>No pneumothorax (n=235)</th>
<th>Total (n=321)</th>
<th>Pneumothorax rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>142</td>
<td>187</td>
<td>24.1</td>
</tr>
<tr>
<td>2</td>
<td>34</td>
<td>79</td>
<td>113</td>
<td>30.1</td>
</tr>
<tr>
<td>≥3</td>
<td>7</td>
<td>14</td>
<td>21</td>
<td>33.3</td>
</tr>
<tr>
<td>Mean value</td>
<td>1.57</td>
<td>1.46</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Discussion

CT-guided percutaneous transthoracic needle biopsy is a well-established, effective, and safe technique for the diagnosis of focal lung lesions (1, 2). FNAB provides high-quality material for the microscopic diagnosis of malignancy when a cytopathologist is present on-site, with a high rate of specific diagnoses for malignant lesions (9, 14). However, the reported sensitivity and diagnostic accuracy rate for benign lesions are much lower and vary from 40% to 70% (3, 7, 11, 15). The main reason for these wide-ranging results depends on the need to obtain a specific benign diagnosis, and core biopsy has a greater ability than fine needle aspirate smears to do this (6, 7). Moreover, FNAB requires the presence of a cytopathologist on-site to assess the adequacy of samples (9–14). Nevertheless, the availability of a cytopathologist varies from one institution to another (7, 16). For these reasons FNAB is less and less used because of the availability of automated biopsy devices with needles of small caliber and co-axial systems. This technique has high diagnostic accuracy for both benign (71–97%) and malignant lung lesions (88–95%) (6, 7) and it is the first-line procedure when a cytopathologist is not immediately available (7). CB improves diagnostic accuracy, particularly for mediastinal masses (such as lymphatic malignancies and thymoma) (17) and for benign lesions (8), but it has disadvantages over FNAB for some features. First of all, CB does not present advantages over FNAB for malignant lung lesions. CHARIG & PHILLIPS (18) and GREIF et al. (19) found the diagnostic yield for malignancy with cutting needle biopsies to be lower than that with FNAB, with a reported CB false negative rate of 8.3%. Furthermore, GREIF et al. (19) showed its inability to determine the specific type of carcinoma, especially squamous cell carcinoma. MONTAUDON et al. (11) demonstrated that the main cause of a false negative histological analysis for malignancy was extensive necrosis of the lesion. Tumoral necrosis is particularly seen in squamous cell tumors and it is rich in dyskeratotic cells (20). The shedding of cells into necrosis helps to provide the diagnosis at cytology. Then, histological analysis of these cases may be negative, while cytology obtained from aspiration is often diagnostic (11). Therefore, in these cases cytology presents advantages over histological analysis. In our study, FNAB with single-pass technique was routinely used and CB with co-axial technique was performed only when fine needle aspiration smears were considered inadequate for a final diagnosis. Following this combined approach, the diagnostic ability of CT-guided percutaneous biopsy of lung lesions significantly improves (6), with similar values of diagnostic accuracy for benign and malignant lung lesions compared to CB. Furthermore, in the present study when comparing the two groups for diagnostic accuracy we obtained similar levels of sensitivity, negative predictive value, and overall diagnostic accuracy, showing that the efficacy of CT-guided FNAB is not significantly affected by the training level of the cytopathologist on-site.

FNAB has other advantages compared with CB. It is the most reliable and safe percutaneous lung biopsy technique when a focal lung lesion is smaller than 1 cm...
(1, 20), and it should always be preferred to CB for these nodules, as suggested by Laurent et al. (2) and Yeow et al. (8). Actually, in sampling such small lung lesions it is impossible to avoid inclusion of normal aerated lung tissue into the 1.3 cm long cutting throw generally used (7, 8). In fact, with use of CB, Yeow et al. (8) reported a 17 times higher risk of pneumothorax and a 6 times higher risk of bleeding for lesions smaller than 2 cm. Although a short-throw cutting needle (10 mm) may be used to avoid bleeding complications in lesions smaller than 1.5 cm, Boiselle et al. (21) reported a low overall diagnostic accuracy rate of 62% when such a needle was used.

Concerning complications in comparison of CB, FNAB presents lower rates of severe and fatal complications. In large studies, Greene (22) estimated the mortality rate associated with fine needle aspiration to be 0.02%, while Tomiyama et al. (23) and Richardson et al. (24) reported rates of 0.07% and 0.15%, respectively, for CB. Most of the deaths were attributed to fatal air embolism. Pneumothorax is by far the most frequent complication following lung biopsy, with reported rates of 22–45% for FNAB and 29–45% for CB, requiring chest drain insertion in 1.6–18% and 3.3–15% of cases, respectively (25). Our pneumothorax rate (27%) was similar to or lower than the reported rates in the literature (22–45%) (4, 22). In our study, many pneumothoraces (85%) did not require evacuation with a chest tube, because they were asymptomatic and stationary in nature. Concerning hemoptysis, in our practice 98% (92 of 94) of bleeding complications were minor and were depicted by CT as lung parenchyma bleeds or bleeds along the needle path. These lung parenchyma bleeds were mostly self-limited, with only 11 patients with hemoptysis. Our hemoptysis rate of 3.4% is equal to the 3.4% occurrence reported using a 19-gauge co-axial cutting needle by Yeow et al. (8), but much lower than the 10–24% frequency of hemoptysis generally reported with CB (3–7). Furthermore, only two patients (0.6%) with severe hemoptysis required medical treatment, with a final positive outcome. The low hemoptysis rate of FNAB compared with CB may be related to the less invasive approach by the FNAB sampling technique. In our study, the training level of the cytopathologist on-site did not affect the safety of the procedure, with similar levels of overall and treated complications between the two groups. Moreover, another finding of our study is that the experience of the cytopathologist on-site does not influence the number of needle passes and pleural punctures performed for the procedure. The role of needle passes in the lesion and pleural punctures, as risk factors for pneumothorax development post biopsy, has been fiercely debated in the literature. Some previous works have not shown any relationship between the number of pleural punctures and/or needle passes in the lesion and the incidence of pneumothorax (2, 5, 10, 16, 18, 22, 26). Poe et al. (26) demonstrated that the incidence of pneumothorax was 30% after the first pleural pass but increased to 43% in the second pass. However, their finding failed to reach a statistically significant level. Halloush et al. (10) and Charig & Phillips (18) obtained similar results for either pleural punctures or needle passes in the lesion. In our study, the increased number of pleural passes was not associated with increased incidence of pneumothorax. In fact, although the number of pleural punctures was slightly higher in patients developing pneumothorax (mean 1.6 pleural punctures versus 1.5 in group without pneumothorax), there was no statistically significant difference between the two groups. On the contrary, in keeping with the findings of other authors, we noted significant increases in the incidence of pneumothorax with increased number of samples obtained (4, 9, 14). Ohno et al. (4) found that the incidence rate of pneumothorax was 18% after the first pass but significantly increased to 53% and 73% in the second and third pass, respectively. In our study, in 228 of 321 cases (71%) the on-site cytologist evaluated the specimen from a single needle aspirate as being sufficient for diagnosis. However, in the remaining cases further passes were performed to obtain diagnostic samples. In these situations, the increased number of needle passes in the lesion increases the risk of pneumothorax. This finding suggests that in creating pneumothorax it is the number of samples obtained that is important and not the number of pleural punctures performed. A possible explanation for correlation between number of samples and pneumothorax rate is presumably due once again to the lesion sampling technique used. This may be explained for CB by the inclusion of normal lung parenchyma around the lesion during sampling. For FNAB, the up-and-down movement of the needle tip during aspiration results in tearing of adjacent lung parenchyma and may influence the shape and size of the pleural hole.

There were some limitations to this study, related to the retrospective nature of our report, with a lack of standardization among operators. First, in the inexperienced group specimens were not evaluated by the same training cytopathologist, but by two different operators alternatively present on-site. In addition, because experienced and training pathologists were present at different times, it was not possible to compare the diagnostic accuracy of FNAB on the same specimen by the two groups of pathologists. Nevertheless, the two groups were comparable because of their homogeneity for patient and lesion characteristics.
In conclusion, the use of core biopsies as the first-line technique for assessing diagnoses of pulmonary nodule or mass is still debated. Considering the described advantages of FNAB, to optimize the performance of the biopsy for either benign or malignant lung lesions and to limit severe complications, FNAB should be considered the initial diagnostic procedure for peripheral lung lesions in centers where immediate cytologic assessment is available by an experienced cytopathologist or a fellow. CB with coaxial technique should be performed only when inadequate samples are obtained by aspiration biopsy.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References