Forceps biopsy and suction catheter for sampling in pulmonary nodules and infiltrates

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Abstract

Transbronchial lung biopsy with forceps is a standard procedure in bronchoscopic tissue sampling. Suction catheter aspiration is another technique, but it is not widely known and almost no data exist about its diagnostic efficiency.

272 patients were included in a prospective and randomised study between February 2007 and October 2009. All were referred for bronchoscopic evaluation of pulmonary nodules/masses or infiltrates. We compared the diagnostic yield of forceps biopsy and suction catheter
aspiration for a definite diagnosis and looked at whether such a diagnosis depends on the underlying pulmonary change.

All patients underwent bronchoscopy with forceps biopsy and catheter aspiration. A definitive diagnosis was reached in a total of 183 patients (67.3%), with catheter aspiration in 140 patients (51.5%) and with forceps biopsy in 136 patients (50.0%). In 90 patients (33.1%) only with the combination of both techniques could a definite diagnosis be reached. The diagnostic yield of forceps biopsy was better than catheter aspiration in infiltrates (p = 0.027), but was no different in nodules/masses (p = 0.09).

Suction catheter aspiration is a useful technique of bronchoscopic tissue sampling. The combination of catheter aspiration and forceps biopsy results in a higher diagnostic yield than either method alone.

Key-words:

bronchoscopy – catheter aspiration – forceps biopsy – pulmonary infiltrates – pulmonary nodules – transbronchial biopsy

Introduction

Bronchoscopy is a standard diagnostic procedure in the evaluation of peripheral pulmonary nodules or masses as well as lung infiltrates. A universal method of bronchoscopic tissue sampling in endobronchial not visible peripheral pulmonary lesions is transbronchial biopsy with forceps [1-3]. Usually, the procedure is performed with fluoroscopy guidance and with a low complication rate [4]. Other common sampling techniques are transbronchial needle aspiration [5] and bronchial brushings [6]. Suction catheter aspiration is another, not widely known, method which was described in 1964 by Friedel [7]. Only a few data exist about its diagnostic efficiency in peripheral pulmonary lesions [8, 9], but it is recommended as a diagnostic procedure in the recently published interdisciplinary guidelines of the German Respiratory Society and German Cancer Society of lung cancer [10].
The aim of the present study was to prospectively evaluate and compare the diagnostic yield of catheter aspiration with transbronchial forceps biopsy as tissue sampling techniques in peripheral pulmonary nodules or masses and lung infiltrates.

**Material and Methods**

**Subjects**

This prospective and randomized study was approved by the Ethics Committee of the University of Dresden. Two hundred and seventy-two patients referred to the Department of Pulmonary Medicine, Fachkrankenhaus Coswig, between February 2007 and October 2009 with undiagnosed peripheral pulmonary lesions on computer tomography of the chest were included in the study after signing an Ethics Committee-approved informed consent. All chest computed tomographs were reviewed by two of the authors (AP and DK) and based on radiologist’s CT-diagnosis the pulmonary lesions were divided into two groups (solid or infiltrative lesions). The size of the solid lesions (nodules or masses) were recorded by their widest diameter and were divided into three groups according to the diameter of the lesion (less than 2 cm, between 2 and 4 cm, and 4 cm and greater); Patients with endobronchial visible abnormality were not included.

**Procedure**

All the procedures were performed by senior physicians and trained bronchoscopists in a bronchoscopy room equipped with a rotating C-arm fluoroscope. Procedures were performed under general anaesthesia (GA), with intubation of a rigid bronchoscope (10318 FL, 12 mm diameter, Karl Storz, Tuttlingen, Germany), or with local anaesthesia (LA) and sedation (midazolam iv). A flexible bronchoscope (FB 19, Pentax, Tokio, Japan) was used for all diagnostic procedures. After careful examination of the bronchial tree, sampling from the peripheral pulmonary lesion under fluoroscopic guidance was performed. Tissue sampling
was done with catheter suction (Rüsch Cannula, Ch 7, 120 cm long, Rüsch, Teleflex Medical, Kernen, Germany) and with biopsy forceps (2.2 mm in diameter, 120 cm long, MTW, Wesel, Germany). Both biopsy techniques were done sequentially in a random order in every patient. The catheter aspiration technique included moving the catheter back and forth while continued suction was applied with a 10-ml syringe. The biopsy forceps technique was done in standard fashion. Both sampling techniques were conducted until a satisfactory macroscopic specimen was obtained, decided in each case by the bronchoscopist. From each sampling technique at least one cytological specimen was also obtained. This was smeared on glass slides and air-dried, before being transferred to the cytological laboratory of the Fachkrankenhaus Coswig where a Mai-Grünwald-Giemsa staining was performed. The histological specimens were grounded in formalin before sending them to an independent pathological laboratory (O. Holotiuk, Institute of Pathology, Dresden, Germany) cooperating with the Fachkrankenhaus Coswig.

All patients had a chest X-ray taken 3-4 hours after the bronchoscopy to evaluate iatrogenic pneumothorax.

Data relating to pulmonary lesion characteristics, diagnostic yield and safety were recorded and analyzed. Bleeding was judged clinically by the need for clinical intervention in light, moderate and severe bleeding [11].

Statistical analysis

The data were expressed as means with standard deviation and range or as absolute or relative frequency. The diagnostic yield of forceps biopsy and catheter aspiration was compared using the McNemar test for correlated dichotomous responses. The proportion of the diagnostic yield between procedures under GA and LA were analysed by $\chi^2$ tests. All p values reported are from explorative two-sided tests and regarded as statistically significant if $p<0.05$. 

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Statistical analysis was performed using statistical software SPSS (Version 17.01; SPSS Inc., Chicago, IL, USA).

**Results**

*Patient demographics and lesion characteristics*

One hundred and ninety-six males and 76 females with a mean age of 68.4 ± 9.9 years (range 36 to 89 years) were examined. The characterization of the chest-CT resulted in 216 (79.4%) solid pulmonary lesions (nodules and masses) and 56 (20.6%) infiltrates. Of the solid pulmonary lesions 14 (6.5%) were below 2 cm diameter, 93 (43.1%) between 2 and 4 cm, and 109 (50.4%) greater than 4 cm.

Sixty-nine (25.4 %) lesions showed pleural contact and 24 (8.8 %) mediastinal contact.

*Diagnosis*

Of the 272 cases enrolled in the study, a definitive cytohistological diagnosis was made on 235 lesions (86.4%), 183 (67.3%) through bronchoscopic tissue sampling with biopsy forceps and/or catheter suction, and 52 (19.1%) through other diagnostic procedures such as repeat bronchoscopy, transbronchial needle aspiration, transthoracic needle aspiration, endosonographic needle aspiration, surgery or microbiological examination of specimens. Malignancy was established in 133 (73.7%) and benign disorders in 63 (27.3%) cases. In 37 (13.6%) cases a definite diagnosis was not made either because the patient refused further examination with definite pathological confirmation or spontaneous regression was observed at control. All diagnoses obtained by forceps biopsy and/or catheter aspiration are reported in Table 1; those obtained by other diagnostic procedures in Table 2. Final diagnoses of solid lesions and infiltrative lesions are reported in Table 3.
Diagnostic yield

All patients underwent a bronchoscopy with forceps biopsy and catheter aspiration as tissue sampling techniques. The overall diagnostic yield is presented in Table 4. A definite diagnosis was reached in a total of 183 patients (67.2%), with catheter aspiration in 140 patients (51.5%) and with forceps biopsy in 136 patients (50.0%). In 90 patients (33.1%) only with the combination of both techniques could a definite diagnosis be reached.

In Table 5 the diagnostic yields associated with the radiological signs of the pulmonary lesions are presented.

The diagnostic yield of forceps biopsy was better than catheter aspiration (53.6% vs. 33.9%, p = 0.027) in pulmonary infiltrates. In solid pulmonary lesions there was a non-significant trend for catheter aspiration to be better than forceps biopsy (56.0% vs. 49.1%, p = 0.091).

With regard to the size of the solid pulmonary lesions, there were no significant differences of the diagnostic yield between forceps biopsy and catheter aspiration (< 2 cm: 35.7% vs. 35.7%, p = 1.0; 2-4 cm: 41.9% vs. 51.6%, p = 0.122; > 4 cm: 56.9% vs. 62.4%, p = 0.418).

Looking at the localization of the pulmonary lesion, there were no significant differences in the diagnostic yield of forceps biopsy and catheter aspiration whether there was a pleural contact (52.2% vs. 47.8%, p = 0.664), or not (49.3% vs. 52.7%, p = 0.47) and whether there was a mediastinal contact (54.2% vs. 58.3%, p = 1.0), or not (49.6% vs. 50.8%, p = 0.826).

There was no significant difference in the diagnostic yield with regard to malignant (p = 0.182) or benign lesions (p = 0.134) when comparing catheter aspiration and forceps biopsy (Table 6).

51.8% of the bronchoscopies were performed under LA and 48.2% under GA. There was no significant difference in the diagnostic yield between the bronchoscopic procedures performed under LA or GA at all (54.1% vs. 45.9%, p = 0.285), neither for catheter aspiration (53.6% vs. 46.4%, p = 0.556) nor for forceps biopsy (52.2% vs. 47.8%, p = 0.903) alone.
Complications

Mild bleeding was observed in 12 cases (4.4%) with catheter aspiration and 38 cases (14.0%) with forceps biopsy (p < 0.05). Moderate or severe bleeding was not observed in this study, and no pneumothorax or deaths occurred with the diagnostic procedures.

Discussion

In this prospective, randomized study of 272 patients with pulmonary peripheral lesions comparing suction catheter aspiration with forceps biopsy as the standard procedure of bronchoscopic tissue sampling, the diagnostic yield was 51.5% with catheter aspiration and 50.0% with forceps biopsy. The diagnostic yield increased to an overall diagnostic yield of 67.3% using both tissue sampling procedures.

The diagnostic yield of fluoroscopy-guided forceps biopsy depends on the size and dignity of the lesion and varies widely. In 91 patients meeting the criteria of a stage I carcinoma and only 13% of benign lesions, Torrington and Kern [12] reported a diagnostic yield of 18%. If the criteria of the nodule size was up to 4cm the range of the diagnostic yield was between 19 to 61% [13-16], and up to 6cm between 36-62% [14, 17]. According to these published reports our overall diagnostic yield of forceps biopsy matches these results.

There are only two reports about studies using catheter aspiration as a bronchoscopic tissue sampling method. Franke and colleagues [8], in a prospective study with 28 patients, compared the diagnostic yield of catheter aspiration and forceps biopsy concerning malignancy in patients with peripheral lung nodules with a tumor size of 41.4 ± 14.5 mm. Catheter aspiration was significantly superior to forceps biopsy (77% compared with 50%) and combining both procedures further improved the diagnostic yield by about 10%. In a recently published report of Eberhardt and colleagues [9] suction catheter aspiration was compared with forceps biopsy in 54 patients for the sampling of solitary pulmonary nodules guided by electromagnetic navigational bronchoscopy (ENB). The overall diagnostic yield of
the two tissue sampling procedures combined with ENB was 75.5%. Of the cases with a
definite cytohistological diagnosis 90% were made using catheter aspiration and only 55%
with forceps biopsy. In 45% only the specimens obtained from catheter aspiration were
positive. The authors stated that catheter aspiration combined with forceps biopsy improves
the diagnostic yield after ENB in small peripheral lesions. The diagnostic yield of ENB varied
between 62.5% [18] and 74% in other settings [19], combined with radial EBUS up to 88%
[20]. Therefore ENB can enhance the diagnostic yield of bronchoscopic tissue sampling in
peripheral lung lesions independent of lesion size. This should be weighed against the
significant higher costs of the equipment and the disposables (9).

We found a significant difference in the diagnostic yield of the two biopsy procedures in
pulmonary infiltrates, where forceps biopsy was superior to catheter aspiration (p = 0.027).
This could be due to the ability of the biopsy forceps to sample more alveolar tissue, whereas
the suction catheter reaches only lesions with intrabronchial findings such as bronchial
carcinomas or bronchiolitis obliterans with organising pneumonia.

We thought that the different stiffness of the two biopsy materials with the softness of the
suction catheter and the rigidity of the biopsy forceps might mean that the diagnostic yield
would be associated with the location of the pulmonary lesion. Reaching the subpleural space
with the soft suction catheter could be difficult as could reaching lesions with mediastinal
contact with the biopsy forceps. However, we found no significant difference between the two
biopsy procedures irrespective of the localisation of the pulmonary lesion.

A few limitations to our investigation should be noted. We did not define how many biopsies
with forceps had to be performed or how often the suction catheter had to be moved back and
forth. The decision to stop the tissue sampling was made by the bronchoscopist, once a
satisfactory macroscopic specimen had been obtained. With regard to the overall diagnostic
yield, which was in the range of other published studies and the low complication rate, we
think this individual decision is superior to a fixed study schedule of, for example, taking at
least four specimens with the forceps. Likewise, bronchoscopy in LA or GA was at the discretion of the responsible bronchoscopist and one could assume that the diagnostic yield is influenced by this decision mainly due to lack of perfect patient cooperation in LA bronchoscopies. But interestingly we found no significant difference in the diagnostic yield between the bronchoscopic procedures performed under LA or GA. Another limitation is that both methods were applied in the same patient even though they were sequentially applied and at random. Therefore a bias cannot be excluded as the localization of the lesion may have been established by the respective first method.

In summary, we have found that suction catheter aspiration is a useful and safe technique of bronchoscopic tissue sampling in pulmonary nodules/masses and infiltrates. Only in lung infiltrates is forceps biopsy superior. Catheter aspiration and transbronchial biopsies with forceps should be performed in all patients to give the best diagnostic yield.

References


**Table 1**

Established diagnosis by forceps biopsy and/or catheter aspiration in the study patients

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Forceps biopsy and catheter aspiration</th>
<th>Only forceps biopsy</th>
<th>Only catheter aspiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignant lesions</td>
<td>65</td>
<td>28</td>
<td>40</td>
</tr>
<tr>
<td>- NSCLC</td>
<td>53</td>
<td>26</td>
<td>37</td>
</tr>
<tr>
<td>- SCLC</td>
<td>7</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>- Metastasis</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Benign lesions</td>
<td>28</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>- Pneumonia</td>
<td>16</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>- Granulomatosis</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>- COP</td>
<td>3</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>- Others</td>
<td>7</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

NSCLC = Non-small cell lung cancer; SCLC = Small cell lung cancer; COP = cryogenic organising pneumonia; others = including actinomycosis, aspergillosis and eosinophilic infiltrates

**Table 2**

Established diagnosis by other diagnostic procedures in the study patients

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeat Bronchoscopy</td>
<td>2</td>
</tr>
<tr>
<td>- NSCLC</td>
<td>2</td>
</tr>
<tr>
<td>TBNA</td>
<td>9</td>
</tr>
<tr>
<td>- NSCLC</td>
<td>6</td>
</tr>
<tr>
<td>- SCLC</td>
<td>1</td>
</tr>
<tr>
<td>TTNA</td>
<td>9</td>
</tr>
</tbody>
</table>
Established diagnosis of solid lesions or lung infiltrations in the study patients

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Solid lesions</th>
<th>Infiltrative lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Malignant lesions</strong></td>
<td>126</td>
<td>7</td>
</tr>
<tr>
<td>- NSCLC</td>
<td>111</td>
<td>5</td>
</tr>
<tr>
<td>- SCLC</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>- Metastasis</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td><strong>Benign lesions</strong></td>
<td>20</td>
<td>29</td>
</tr>
</tbody>
</table>

NSCLC = Non-small cell lung cancer; SCLC = Small cell lung cancer; COP = cryogenic organising pneumonia; TBNA = transbronchial needle aspiration; TTNA = transthoracic needle aspiration; EUS = endoesophageal ultrasound
### Table 4
Diagnostic yield (No. of patients and %) of different bronchoscopic sampling techniques in the study patients

<table>
<thead>
<tr>
<th>Definite diagnosis</th>
<th>235 (86.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- with bronchoscopy (CA and/or FB)</td>
<td>183 (67.3)</td>
</tr>
<tr>
<td>- with CA</td>
<td>140 (51.5)</td>
</tr>
<tr>
<td>- with FB</td>
<td>136 (50.0)</td>
</tr>
<tr>
<td>- with CA or FB</td>
<td>90 (33.1)</td>
</tr>
<tr>
<td>- with other sampling techniques (Re-bronchoscopy, TBNA, TTNA, EUS, surgery, etc.)</td>
<td>52 (19.1)</td>
</tr>
<tr>
<td>No definitive diagnosis</td>
<td>37 (13.6)</td>
</tr>
</tbody>
</table>

CA = catheter aspiration; FB = forceps biopsy; TBNA = transbronchial needle aspiration; TTNA = transthoracic needle aspiration; EUS = endoesophageal sonography

### Table 5
Diagnostic yield (in %) of the two different bronchoscopic sampling techniques associated with radiological signs and location of pulmonary lesions

<table>
<thead>
<tr>
<th>CA</th>
<th>FB</th>
<th>p-value</th>
</tr>
</thead>
</table>

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Table 6

Diagnostic yield (in %) of the two different bronchoscopic sampling techniques associated with the dignity of pulmonary lesions

<table>
<thead>
<tr>
<th>Lesion Type</th>
<th>CA</th>
<th>FB</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary nodules and masses</td>
<td>56.0</td>
<td>49.1</td>
<td>ns</td>
</tr>
<tr>
<td>&lt; 2 cm</td>
<td>35.7</td>
<td>35.7</td>
<td>ns</td>
</tr>
<tr>
<td>2-4 cm</td>
<td>51.6</td>
<td>41.9</td>
<td>ns</td>
</tr>
<tr>
<td>&gt; 4 cm</td>
<td>62.4</td>
<td>56.9</td>
<td>ns</td>
</tr>
<tr>
<td>Pulmonary infiltrates</td>
<td>33.9</td>
<td>53.6</td>
<td>0.027</td>
</tr>
<tr>
<td>Pleural contact</td>
<td>47.8</td>
<td>52.2</td>
<td>ns</td>
</tr>
<tr>
<td>Mediastinal contact</td>
<td>58.3</td>
<td>54.2</td>
<td>ns</td>
</tr>
</tbody>
</table>

CA = catheter aspiration; FB = forceps biopsy