CT Fluoroscopy-Guided vs Multislice CT Biopsy Mode-Guided Lung Biopies: a preliminary experience

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Aims and objectives

Percutaneous lung biopsies are often performed using CTF to assure accurate needle placement and maximize diagnostic yield. However, CTF exposes both the operator(s) and the patient to ionizing radiation [1]. The first reported case of the use of computed tomography (CT) to guide biopsy was published in 1975 [2]. By 1976, CT was singled out as the single most accurate method for guiding biopsy [3]. Percutaneous CT-guided biopsy of pulmonary nodules has been shown to be an accurate and safe procedure for making a tissue diagnosis of lung lesions [4][5]. To achieve optimal biopsy results, reliable verification of the needle position throughout the intervention is essential. The needle position can be verified by performing intermittent spiral CT scans or by CT fluoroscopy (CTF). Intermittent spiral CT scans are usually limited to the region of the biopsy and may or may not be performed using a low-dose technique. While performing intermittent spiral CT scans, the personnel performing the intervention are required to leave the CT room to avoid the risk of exposure to radiation. In contrast to intermittent spiral CT scans, CTF allows real-time guidance of the needle to the pulmonary nodule. In CTF guided biopsies, the radiologist performing the intervention have images in real time, which allow a continuous visualization of the needle position and he does not leave the CT room. CTF-guided biopsies, however, are reported to be associated with a substantial radiation exposure to patients and personnel [6][7]. Various reports have analyzed factors thought to influence the diagnostic accuracy and the complication rate of CT-guided transthoracic needle aspiration biopsy [8][9]. The aim of our study was to compare CTF-guided with multislice CT (MS-CT) biopsy mode-guided biopsies with regard to the complications, duration of the intervention and radiation dose.
Methods and materials

Patients

Between August 20th 2009 and January 14th 2014, 24 lung biopsies were performed using the CT fluoroscopy technique (group A) and 22 lung biopsies were performed using the MS-CT biopsy mode technique, (group B). The patients have been assigned to the two different CT-guided biopsy methods, randomly.

CT Protocol

CTF-guided biopsies were performed with GE Bright Speed 16: 120 kV, 30 mA s, rotation time 0.5 s, slice thickness 2,5 mm. Images were reconstructed and displayed at 6 frames per second. CTF was performed using either intermittent or continuous fluoroscopy, as indicated. MS-CT biopsy mode-guided biopsies were performed on GE Bright Speed 16 using the biopsy mode with the following scan parameters: 120 kV, auto mA s, rotation time 0.5 s, slice thickness 2,5 mm ×1,375 . Image acquisition was controlled with a foot pedal for only CT-fluoroscopy techniques. The table position was controlled by the Radiologist under sterile conditions using a joystick attached to the table. During the intervention, only the Radiologist performing the intervention was present in the CT suite. To search for possible early complications, a low-dose CT of the region of the biopsy was performed immediately after the removal of the guide needle from all patients. After 4 h all patients made a chest radiography to evaluate the complications. The decision to drain a pneumothorax was left to the discretion of the radiologist performing the intervention when the pneumothorax was observed in the CT room or to the treating physician if the complication was observed later.

Biopsy Technique

All biopsies were performed using a 18G cutting needle with Ultimate (Zamar) and Precisa (HS). The core biopsy samples were fixed in a formalin solution for histopathologic analysis. The biopsies were performed by the same interventional Radiologist.

Statistical Analysis

All statistical analyses were performed with Microsoft Excel software. For metric variables, the two groups were compared using two-tailed Mann-Whitney U-tests due to skewed data.
Results

The demographic data of the patient populations and the lesion characteristics are summarized in Table 1. The two groups of patients are comparable, as they do not differ significantly regarding sex and age of the patients. Also, the lesions of the two groups do not differ significantly location and size. In group A the minimum diameter was 1.3 cm and the maximum diameter was 9.9 cm. In group B the minimum diameter was 1.1 cm and the maximum diameter was 9.0 cm. In group A the lesion was located adherent to pleura in thirteen patients whereas in group B in twelve patients. In group A the lesion was distant to pleura between 1 and 20 mm in eight patients whereas in group B in three patients. In group A the lesion was distant from the pleura more than 20 mm in one patient whereas in group B in nine patients. In the two groups the lesion was most frequently located in the left upper lobe (LSS).

Among the two groups, submitted to the two different CT-guided biopsy, no statically significative difference resulted for what concern the percentage of lesions diagnosed by histological examinations as benign lesions and as malignant lesions. In group A, the percentage of benign lesions found was 9.1% while the percentage of malignant lesions was 86.4%. In group B, the percentage of benign lesions found was 29.2% while the percentage of malignant lesions was 58.3%.

In addition between the two groups (A and B) no significative statistical difference has arisen for what concern the percentage of material taked during the CT lung biopsy. In group A, the material removed was insufficient to make a diagnosis in one patient (4.5%) while in group B the material was insufficient in three patients (8.3%).

The onset of the different complications, the time for the procedure of the biopsy and the dose are summarized in Table 2.

The frequency of pneumothorax was not statistically significantly different between group A and B (40% and 25%, respectively; p-Value 0.495) all with a thickness less than 1.5 cm and the chest tube was not required to be positioned (Fig. 1,2). There is no statistically significant difference, between the two groups, even for the onset of parenchymal bleeding, which was observed in 22% group A and in 33% group B (p-Value 0.538). The bleeding was asymptomatic in all patients. In none of the two groups haemoperitoneum has occurred.

The procedural time is considered the time interval from the insertion of cutting needle to the last image of the final low-dose CT for the control of post-procedural complications. In our study, the duration of the procedure was not statistically significantly different in group B than in group A, respectively 7.9 minutes vs 8.7 minutes (p-Value 0.468).
Primary dosimetric quantity data, the dose length product (DLP) in mGy cm was measured by the CT unit. Analysis of estimated patient related radiation exposure showed no statistically significant difference between conventional and fluoroscopic CT-guided procedures; group A 968.90 mGy cm, group B 903.9 mGy cm (p-Value 0.743).
**Fig. 1:** 61-year-old woman with squamous cell carcinoma in left upper lobe diagnosed at conventional CT-guided biopsy (conventional method). Initial puncture was performed without penetrating pleura. CT images were obtained to check course of biopsy needle. When the pulmonary nodule is penetrated, the position of the tip of the needle is controlled with scans tc

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Fig. 2: 61-year-old woman with squamous cell carcinoma in left upper lobe diagnosed at conventional CT-guided biopsy (conventional method). A low-dose CT of the region of the biopsy was performed immediately after the removal of the guide needle to evaluate the onset of complications

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Fig. 3: 65 year-old woman with ground-glass opacity nodule (adenocarcinoma) diagnosed at fluoroscopy CT-guided biopsy. CT fluoroscopic image obtained with the intermittent (quick-check) method (CT fluoroscopy) the images were obtained to check course of biopsy needle.

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Fig. 4: 65 year-old woman with ground-glass opacity nodule (adenocarcinoma) diagnosed at fluoroscopy CT-guided biopsy. A low-dose CT of the region of the biopsy was performed immediately after the removal of the guide needle shows the onset of pneumothorax.

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Table 1: Demographic dates for the investigated patients and lesion’s characteristics (size, location, histological diagnosis).

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<table>
<thead>
<tr>
<th>Complication</th>
<th>MSCT</th>
<th>CT-fluoroscopy</th>
<th>p-Value</th>
</tr>
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<tbody>
<tr>
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<td>0</td>
<td></td>
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<td>Pneumothorax</td>
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<td>0.495</td>
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<tr>
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<td></td>
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<tr>
<td>visible after 4 hours</td>
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<td>0</td>
<td></td>
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<tr>
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<td>0</td>
<td></td>
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<tr>
<td>Blood Suffusion Perilesional</td>
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<td>8</td>
<td>0.538</td>
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<tr>
<td>Procedure Duration</td>
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<td>0.468</td>
</tr>
<tr>
<td>Dose mGy</td>
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<td>903.95</td>
<td>0.743</td>
</tr>
</tbody>
</table>

**Table 2:** Table Comparison between the onset of the different complications, the time for the procedure of the biopsy and the dose

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Conclusion

Radiation exposure, due to CT examinations, has become a subject of increasing importance in the medical community and in the general population [10][11]. Although there is a continual discussion on the extent of the risk associated with low-dose ionizing radiation, there is a shared opinion that the radiation dose in diagnostic procedures should be as low as reasonably achievable. CT-guided interventions are reported to be associated with considerably high patient effective doses [1]. Our findings demonstrate that chest biopsies using the MS-CT biopsy mode, different from CTF-guided biopsies, can be carried out without lowering the CTDI levels. Furthermore, there is not a statistically significant difference between the two different techniques, with regards to the onset of post-procedural complications, nor a difference of the duration of the procedure. It is most likely that the factors that determine the reduction of procedure time, the risk of complications and the dose of exposure are related to the size and location of the lesion. In addition, the more the lesion is localized in an easily accessible zone and larger in size the lesion and the risk of complications is reduced as well as the procedure time and the dose of exposure is diminished.

Lesion depth is the predominant risk factor for pneumothorax in patients undergoing CT-guided transthoracic lung biopsy [12]. Increased lesion depth and smaller lesion size correlated strongly with the development of pneumothorax; in the study of Kazerooni EA et al. [13] the pneumothorax occurred in 54 of 121 procedures (44.6%). In the study of Laurent F et al. [12] the pneumothorax occurred in 61 (19.9%) of the 307 patient. To reduce the risk of pneumothorax necessitating chest tube placement, physicians should adopt the shortest needle path to the lesion [14]. Pneumothorax and pulmonary hemorrhage are the most common complications of percutaneous needle biopsy of the chest, whereas air embolism and tumor seeding are extremely rare. Attention to biopsy planning and technique and postprocedural care help to prevent or minimize most potential complications [15]. In our study the procedures were all performed by a single experienced interventional radiologist to limit the variables of physician expertise, interventional material use, and biopsy approach. The results indicate there is no significant difference between the two groups regarding post procedure pneumothoraxes using CTF rather than the conventional technique. The radiation dose given to the patient was similar, although slightly less using CT-fluoroscopy. Considering the fact that the use of fluoride TC also exposes the medical personnel to ionizing radiation without any obvious benefits, based on the findings from this study, in combination with our operational experience, interventional radiologist in our Department is no longer using the fluoroscopy-tc as a guide for biopsies.

Among the limitations of our study we must keep in mind the limited number of the subjects examined.
References

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[10]

[11]

[12]


[14]