CLINICAL SCIENCE

Predictive complication factors for ct-guided fine needle aspiration biopsy of pulmonary lesions

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OBJECTIVE: Distinct aspects can influence the complication rates of computed tomography-guided percutaneous fine needle aspiration biopsy of lung lesions. The purpose of the current study is to determine the influence of radiological techniques and clinical characteristics in predicting complications from this procedure.

SUBJECTS AND METHODS: A retrospective study was developed involving 340 patients who were submitted to a consecutive series of 362 computed tomography-guided fine needle aspiration biopsies of lung lesions between July 1996 and June 2004, using 22-gauge needles (CHIBA). Variables such as the radiological characteristics of the lesions, secondary pulmonary radiological findings, co-morbidities, and aspects concerning the procedure were studied.

RESULTS: The diameters of the lung lesions varied from 9 to 140 mm, with a mean of 51.5 $\pm$ 24.3 mm and median of 40 mm. The depth of the lesions varied from 10 mm to 130 mm, with a mean of 44 $\pm$ 20.9 mm, and median median of 52 mm. Complications occurred in 52 (14.4%) cases, pneumothorax being the most frequent, with 40 (11.1%) cases, followed by hemoptisis with 7 (1.9%) cases, and hematoma with 4 (1.1%) cases. Lesions that did not contact the pleura, with normal pulmonary tissue interposition between lesion and pleura, had higher complication rates, with 22 (22%) cases, than lesions that contact the pleura, with 6 (9%) cases, with a statistically significant difference ($p = 0.03$).

CONCLUSIONS: CT-guided percutaneous fine needle aspiration biopsy of lung lesions had a lower rate of complications in our study and presented more rates of complications on lesions that lack pleural contact.

KEYWORDS: Fine; Needle; Biopsy; Lung; Complication.

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INTRODUCTION

There is a significant variation in literature regarding the potential for complications with computed tomography (CT)-guided percutaneous fine needle aspiration biopsy (FNAB) of thoracic lesions. The incidence of complications ranges between 7% and 62%; pneumothorax is the most frequent complication, and thoracic draining ranges between 1% and 31%.[1-5]

Identifying characteristics such as the radiological aspects of the lesions, secondary pulmonary radiological findings, procedural aspects, and clinical characteristics such as co-morbidities can help uncover the reason for complications in patients submitted to the CT-guided FNAB of lung lesions.[6-7] The purpose of this study is to evaluate the influence of these characteristics in predicting complications from CT-guided FNAB of lung lesions.

SUBJECTS AND METHODS

This is a retrospective analysis of all consecutive patients who received CT-guided FNAB of pulmonary lesions at an oncological center in Brazil between 1996 and 2004. From a total of 491 procedures evaluated, 362 (73.7%) were considered eligible for this study. Of the 129 excluded procedures, 6 (1.2%) were excluded because after cytological evaluation or upon follow-up, the lesions were defined as being on the chest wall or pleura; 26 (5.3%) were excluded for having divergences between the admission and chart registrations; and 97 (19.8%) were excluded because the procedure was performed with cutting needles, which are not the subject of this study. A total of 362 procedures performed on 340 patients are reported here; of these 362 procedures, 319 were of lesions that were submitted to biopsy once; 20 were of lesions submitted to biopsy twice; and one was of a lesion submitted to biopsy three times. Written informed consent was obtained from all patients. Information was collected from the charts available at the hospital's Medical Archive Service (MAS) and the percutaneous biopsy forms. These forms contain data regarding the location, size, and number of the lesions, the

distance between the lesion and the needle entrance site, contour aspects of the lesions, and the relationship of the contour aspects to adjacent structures such as the mediastinum, or chest wall. Secondary radiological findings such as atelectasis, pleural effusion, cavitations, necrosis, infiltrates, adenopathy, and the presence of other tumors and comorbidities were also included. Radiologic findings were based on the CT report prior to the procedure; the FNABs were conducted by an oncologic radiologist with over 10 years experience in CT-guided FNAB, or by a resident in radiology under his guidance, following the standard procedure defined by the Department of Radiology.[8]

At the Department of Radiology, coagulation tests were checked routinely; when these tests were within normal parameters, the biopsy was planned and performed using a chest CT with thin slices (3–5 mm). The computer's cursor was used to measure the size of the lesions and the distances of the lesions from the biopsy needle entrance site. The skin was prepped with an antiseptic solution, and local anesthesia, with 1% lidocaine, was applied. The puncture needle was introduced, and new tomographic cuts were obtained in order to confirm or modify the needle position. The biopsies were performed within a breath-hold.

The FNABs were performed using 22-gauge CHIBA-type needles; subsequently, the obtained material was prepared in smears and immersed in 90% alcohol. Due to the retrospective nature of our study, it was not possible to determine the number of thoracic transfixations done via the FNAB procedure. However, the number of thoracic transfixations was indirectly obtained using the number of smears made by the puncture. In the experience of the Department of Radiology at the Hospital of Cancer, each puncture will supply approximately 4 smears.

Complications were considered when any new radiological occurrence was presented at the control exams with thoracic tomography being performed after biopsy, as well as new clinical symptoms and signs such as shortness of breath, intense dyspnea, thoracic pain, and hemoptisis appearing after biopsy.

Control exams with 10 mm axial tomographic cuts involving the entire thorax were performed immediately and 2 to 4 hours after the procedure to confirm the presence of complications such as pneumothorax and hematoma.

Pneumothorax was considered present when any material with aerated density accumulated in the pleural space. The tomographic control exam was anticipated if the patient demonstrated any signs or symptoms of acute respiratory discomfort. Hematoma was considered for each new opacification that was related to the lesion and to the contiguous pulmonary normal tissue that appeared following the puncture.

The presence of hemoptisis during and in the first 24 hours following the puncture was considered a complication as well.

By correlating the patient radiological data and comorbidities with complication occurrence, we were able to determine the predictive factors for complication rates of CT-guided FNAB of lung lesions. Descriptive statistics were used when applied; the chi-square test or Fisher's exact test was applied when appropriate. A P value was considered statistically significant when equal to or less than 0.05.

RESULTS

Of the 362 FNABs performed, 212 (58.6%) were performed on male patients, and 150 (41.4%) were performed on female patients. The mean age was 61 $\pm$ 16 years, and the median age was 63 years old. The purpose of the FNAB referral was to obtain a primary diagnosis of a suspected malignant focal lesion in 215 (59.4%) procedures and to document possible secondary malignancy in 147 (40.6%) procedures.

The lung lesions were right-sided in 163 (45%) procedures, and left-sided in 154 (42.5%) procedures. The lesion distribution by pulmonary lobes was as follows: 76 (21.0%) on the left superior lobe, 60 (16.6%) on the right superior lobe, 58 (16.0%) on the right inferior lobe, 48 (13.3%) on the left inferior lobe, and 27 (7.5%) on the middle lobe. In addition, this information was not available in 93 cases (25.7%).

The diameters of the lung lesions varied from 9 to 140 mm (mean: 51.5 $\pm$ 24.3 mm; median: 40 mm); the distance between the lesion and the biopsy entry point on the skin varied from 10 to 130 mm (mean: 44 $\pm$ 20.9 mm; median: 52 mm). Additionally, 71 (40.1%) lesions were in contact with the pleura, and 106 (59.9%) had pulmonary tissue between the lesions and the pleura. The lesion contour type was irregular in 96 patients (26.5%), spiculated in 38 patients (10.5%), smooth in 37 patients (10.2%), and lobulated in 22 patients (6.0%); this information was not available in 169 cases (46.8%). In 148 (40.9%) procedures, the patient had one lung lesion, and in 25 (6.9%) of the procedures, the patient had two lesions. In 22 (6.1%) of the procedures, the patients had three lesions, and in 43 (11.9%) of the procedures, four or more lung lesions were present.

The most common secondary radiologic findings were adenopathy (34 patients; 9.4%), additional tumors (32 patients; 8.8%), cavitation (16 patients; 4.4%), necrosis (14 patients; 3.9%), infiltration (13 patients; 3.3%), pleural effusion (10 patients; 2.8%), and opacification on the present lesion (4 patients; 1.1%).

From a total of 362 needle biopsies, a cytological result was obtained from the patients' charts for 357 (98.5%) of those biopsies. Of the 357 punctures evaluated by the pathologist, the material was considered adequate for analysis in 304 biopsies (84%) and inadequate for analysis in 53 biopsies (14.6 %). The frequency of material adequacy for cytological analysis is shown in Table 1.

From a total of 362 biopsies, complications occurred in 51 (14.1%), pneumothorax being the most frequent. No

Table 1 - Cytological analysis results of 357 FNABs.

Material	n	(%)
Adequate for Analysis		
Malignant	204	56.4
Suspicion of malignancy	38	10.5
Negative for malignancy	45	12.4
Possibly Benign	17	4.7
Total	304	84.0
Inadequate for Analysis		
Insufficient	44	12.1
Inadequate	9	2.5
Total	53	14.6
No information	5	1.4
Total	362	100

Table 2 - Distribution of complications rates of CT-guided FNAB of lung lesions.

Complications	n	(%)
Pneumothorax	40	11.1
Hemoptisis	07	1.9
Hematoma	04	1.1
No Complications	281	77.6
No Informations	30	8.3
Total	362	100

complications were reported in 281 (77.6%) cases, and there was no available information in 30 (8.3%) cases, according to Table 2.

There was no difference in the complication rates in patients of different gender or age groups. There was also no statistical difference in complication rates for biopsies performed in groups of patients with different secondary radiological lung findings.

Table 3 shows the distribution of the radiologic characteristics of the lesions and the corresponding rates of complications. The frequency of complications was higher in lesions that lacked contact with the pleura and with normal pulmonary tissue interposition between lesion and pleura, than in the lesions that maintained contact with the pleura (p = 0,03). There was no statistical difference in complication rates with the others radiological characteristics of lesions.

Table 3 - Analysis of lung lesions radiological characteristics and occurrence of complications in CT-guided FNAB of lung lesions.

Variables	n (%)	n No Complic (%)	n Yes Complic (%)	p
Contours				0.96
Smooth	37 (20.1)	5 (13.5)	32 (86.5)	
Lobulated	22 (11.9)	3 (13.6)	19 (86.4)	
Spikulated	34 (18.4)	4 (11.8)	30 (88.2)	
Irreg n especif.*1	91 (99.6)	14 (15.4)	77 (84.6)	
Width*2				0.11
≤52mm	106 (48.8)	15 (14.2)	91 (85.8)	
> 52mm	111 (51.2)	25 (22.5)	86 (77.5)	
Lung				0.06
Right	153 (51.3)	26 (17.0)	127 (83.0)	
Left	145 (48.7)	23 (15.9)	122 (84.2)	
Size*3				0.79
<40mm	133 (49.9)	20 (15.0)	113 (85.0)	
≥40mm	134 (50.1)	24 (17.9)	110 (82.1)	
Number of lesions				0.32
One	141 (62.3)	24 (17.0)	117 (83.0)	
Two	24 (10.6)	5 (20.8)	19 (79.2)	
Three	18 (7.9)	1 (5.6)	17 (94.4)	
Four or more	43 (19.2)	4 (9.3)	39 (90.7)	
Lobes				0.23
Superiors	130 (50.5)	19 (14.6)	111 (85.4)	
Middle	27 (10.5)	2 (7.4)	25 (92.6)	
Inferior	100 (39)	20 (20)	80 (80)	
Pleura Contact				0.03
Yes	67 (40.1)	6 (9.0)	61 (91.0)	
No	100 (59.9)	22 (22.0)	78 (78.0)	
Vital Organs*4				0.27
Yes	30 (17.9)	3 (10)	27 (90)	
No	137 (82.1)	25 (18.2)	112 (81.8)	

*1 **Irreg. non-specif.**, when contour of pulmonary injury was classified as irregular by radiologist without other specifications.
*2 **Superficial**, when less or equal to the medium size; deep, when larger than the medium size.
*3 **Smaller Size**, when less or equal to the medium size; larger size, when larger than the medium size.
*4 **Vital Organs,** when there is a relation to structures considered as vital: heart, main bronchi, heart, pulmonary hilum, trachea, pericardium, inferior vena cava, aorta and pulmonary arteries and veins.

There was no difference in the complication rates of patients belonging different co-morbidity groups. The information of co-morbidity was presented in 96 patients, as shown in Table 4.

Of the 51 (14.1%) patients who had complications, only 11 (21.1%) needed thoracic draining. Chronic obstructive pulmonary disease (COPD) was the most common co morbidity, with 5 (17.2%) cases of thoracic drainage. In contrast, of the patients without COPD, 4 (5.8%) cases demonstrated a statistically significant difference ($p < 0.01$).

The total number of smears was not predictive of complication rates.

DISCUSSION

Pneumothorax, pulmonary hematoma, and hemoptisis are the most frequent complications of pulmonary biopsy guided by imaging methods.[4,6,7,10,11,14,16]

The incidence of complications in CT-guided FNAB of lung lesions depends on several factors. Radiological and clinical characteristics such as size and depth of lesions, advanced age, abnormal tests of pulmonary function, and co-morbidities can contribute to the occurrence of complications.[11-13]

Austin and Cohen (1993) demonstrated that lesions that contact the pleura do not develop into pneumothorax.[16] Yankelevitz et al. (1997) demonstrated that the rate of pneumothorax was 20%, and that only 5.3% needed draining. They also observed that an increase in the frequency of pneumothorax occurred in lesions that were more than 30 mm away from the pleura, or nodules smaller than 10 mm.[5] Wallace et al. (2002) demonstrated the highest rate of complications among the revised works, with CT-guided FNAB of lung lesions smaller than 10 mm presenting pneumothorax in 62% of the cases and thoracic drainage in 31% of the cases.[5] One reason for this is that the multiple needles tranfixations of the pleural space could be needed to reach small and deep lesions when compared with superficial and large lesions.

Li et al. (1996) had not demonstrated significant differences in the rates of complications of FNAB of lung lesions

Table 4 - Complications rates according to co-morbidity frequency.

Comorbity	n	(%)
COPD*1	30	8.3
Hypertension	29	8.0
Diabettes	18	5.0
IHD*2	05	1.4
CHF*3	04	1.2
Obesity	04	1.1
Others*4	06	1.6

*1 COPD - Chonic Obstructive Pulmonary Disease.
*2 IHD- Ischemic Heart Disease.
*3 CHF- Congestive Heart Failure.
*4 Others– Rheumatoid Arthritis, Lupus.

with equal and smaller diameter than 15 mm versus FNAB of lung lesions larger than 15 mm.[22] In the present work there was no statistically significant difference in the ratio of complications (p = 0,11) or the FNAB of superficial or deep lesions, taking as reference the median (52 mm). However, our study demonstrated more rates of complications on lesions that lack contact with pleura, which could be considered a landmark in differentiate that is superficial from deep lesions.

Chojniak et al. (2006) demonstrated a rate of complication in 16%, and thoracic draining in 4.9% of patients submitted to CT-guided FNAB of lung lesions. [8] In our work, the rate of pneumohorax was 11.1% and thoracic draining, 3.0%.

The Department of Radiology of Hospital AC Camargo is a reference service and routinely performs CT-guided FNAB.[4,8,19] Perhaps the acquired experience, with procedures over the past years, can minimize the occurrence of complications in small and deep lesions of FNAB. However, according the retrospective nature, this study could have underestimated the rates of complications.

Yu's et al. (2002) study on CT-guided percutaneous biopsies with cutting needles presented a rate of 17.3% complications, including: small pneumothorax with no draining required (11.5%), hemoptisis (1.9%); pulmonary hematoma (1.9%) and hematoma in the chest wall upon needle trajectory (1.9%).[4] Sulhatin et al. (2002) demonstrated rates of 1.7% for hemoptisis and 1.4% for pulmonary hematoma, also without significant clinical repercussions.[11] Conces et al. (1987) reveal rates of pulmonary hematoma and hemoptisis as 11% and 2%, respectively, with spontaneous resolution.[16] In our study, the occurrence of complications such as hemoptisis and pulmonary hematoma was 1.9% and 1.1% respectively, with the same frequency found in the literature. No cases of artery embolism and tumor implantation were observed.

Pneumothorax occurrence increased following FNAB in patients with COPD.[13] Romano et al. (2004) found a pneumothorax rate of 11.8% (27) in his study on CT-guided FNAB lung lesions. Of these, only 6 (22.2%) required thoracic draining, but they all suffered from COPD. [15] Vitulo et al. (1996) demonstrated that no parameter of functional results were predictive for pneumothorax. The only variables that correlated significantly with pneumothorax in this study were the interposition of normal tissue ($p<0.01$) and the depth of needle penetration in parênquima ($p<0.05$).[12] On its own, COPD was not predictive for pneumothorax in our study. This result could have been influenced by the reduced amount of information collected in relation to the expected amount for the co-morbidities.

Kazerooni et al. (1996) demonstrated that there was a higher rate of thoracic drainage in the population with severe COPD.[13] In our study, thoracic draining also occurred with more frequency in patients with COPD, with a statistically significant difference ($p<0.01$) in relation to those without this co-morbidity. Although pulmonary function has not been evaluated in the present study, these patients usually have weak lung function and are susceptible to more precocious and evident clinical manifestations, even with a small pneumothorax, which makes them require thoracic draining more frequently than those without COPD.

CONCLUSION

CT-guided percutaneous FNAB of lung lesions had a lower rate of complications in our study and presented higher rates of complications on lesions that lack pleural contact. COPD was the most common co-morbidity finding, with higher rates of thoracic drainage. These radiological and clinical characteristics should therefore be considered when ordering this procedure.

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