Complications of Computed tomography-guided fine needle aspiration biopsy (FNAB) of pulmonary lesions:Factor related

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Abstract

A retrospective review of 209 patients who were submitted to a consecutive computed tomography-guided FNAB of lung lesions between Jan 2010 and Jan 2014,by using 21gauge needles (CHIBA). The factors including radiological characteristics of the lesion, biopsy technique and complications were recorded. Complications occurred in 58 (27.7%) cases, pneumothorax being the most frequent, with 32 (15.3.1%) cases, followed by pulmonary hemorrhage 26 (12.4%) cases. The risk factors included smaller lesion(<4 cm diameter),increased depth of lesion(>4cm),location,loss of pleural contact,frequency of needle adjustment and CT evidence of chronic obstructive pulmonary disease (COPD),with a statistically significant difference (p <0.05)

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INTRODUCTION

Percutaneous transthoracic fine needle aspiration biopsy (FNAB) of the lung is a well-established method in the cytologic diagnosis of pulmonary nodules. Haaga and Alfidi[1] reported computed tomography (CT)-guided biopsy in 1976, and numerous reports have shown FNAB procedures to be both effective and accurate[2-9]. The diagnostic accuracy has been reported more than 80% for benign disease and greater than 90% for malignant disease[2-8].

CT-guided FNAB is generally regarded as a safe procedure with limited morbidity and extremely rare mortality[2-9] Pneumothorax remains the most frequent complication of FNAB, and tube thoracostomy is occasionally required for treatment, [10-11]. Reported frequency of pneumothorax for CT-guided procedures varies from 8% to 64%[2-11]. Fatal complications due to air embolism, hemorrhage, or pericardial tamponade have been reported [9,10,11] . but these are rare. The purpose of our study was to determine the influence factors in predicting complications.

SUBJECTS AND METHODS

This is a retrospective analysis of all consecutive patients who received CT-guided FNAB of pulmonary lesions at an intervention unit in R adiology department ,Suratthani hospital between Jan 2010 and Jan 2014. The total of 209 patients were evaluated. Written informed consent was obtained from all

patients. Information was collected from the charts and requested form. The collected data included the location,size,the distance between the lesion and the needle entrance site ,the pleura contact,frequency of needle adjustment, an CT evidence of chronic obstructive pulmionary disease(COPD) or emphysematous lungs. The FNABs were conducted by an interventional radiologist at the department of Radiology.

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 21-gauge CHIBA-type needles; subsequently, the obtained material was prepared in smears and immersed in 90% alcohol. 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 The new clinical symptoms and signs such as shortness of breath, intense dyspnea, thoracic pain, and hemoptyis appearing biopsy were observed.

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 pulmonary hemorrhage.The presence of hemoptysis during and in the first 2 hours following the puncture was considered a complication as well.

By correlating the patient radiological data and co-morbidities 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 was applied when appropriate. A P value was considered statistically significant when equal to or less than 0.05.

RESULTS

Of the 209 patients,150 (71.8%) were male, and 59 (28.2%) were female. The age was between 15-85 years old. The mean age was 53.9 years.. The purpose of the procedures was to document possible malignancy in 147 (70.3%) procedures.

The lung lesions were in right lungs 100 patients (47.8%) , and in left lungs 109 patients(52.2%). The lesion distribution by pulmonary lobes was as follows: 107 (51.2%) in the upper lobes,62 (29.7%) in the middle lobes and 40(19.1%)in lower lobes..

The diameters of the lung lesions varied from 1cm to 9cm (mean: 4.2 cm). The distance between the lesion and the biopsy entry point on the skin varied from 1.5 cm to 9 cm(mean 5. cm). The 58 lesions (27.7%) were in contact with the pleura.

The total of 209 tissue biopsies were evaluated by the pathologist. The material was considered adequate for analysis in 189 biopsies (90.4%) and inadequate for analysis in 20 biopsies (9.6%), shown in Table 1.

Table 1 – Cytological analysis results of 209 FNABs.

Material	n	(%)
Adequate for Analysis		
Malignant	115	55
Suspicion of malignancy	19	9
Negative for malignancy	17	8.1
Possibly Benign	38	18.3
Total	189	90.4
Inadequate for Analysis		
Inadequate	20	9.6
Total	209	100

From a total of 209 biopsies, complications occurred in 58 patients (27.7%), pneumothorax being the most frequent(15.3%),followed by pulmonary hemorrhage(12.4%) with 2.4% of self-limited hemoptysis,according to Table 2

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

Complications	n	(%)
Pneumothorax	32	15.3
Pulmonary hemorrhage	26	12.4
Hemoptysis (self-limited)	5	2.4
No complication	151	72.2
Total	209	100

The correlation between factors and pneumothorax are shown in table3. The risk factors include CT evidence of COPD or emphysematous lung,middle lobe lesion,lesion size <4 cm diameter,the increased depth from the skin to lesion >4 cm,more needle adjustment and lack of pleural contact ($p<0.05$).

Table 3 show correlation between factors and pneumothorax.

Characteristic, n	Pneumothorax, n	Non-pneumothorax,n	P-value
Gender			0.820
Male	24	126	
Female	8	51	
Age			0.775
<49 (75)	10	65	
50-69 (112)	19	93	
>70 (22)	3	19	

Characteristic, n	Pneumothorax, n	Non-pneumothorax,n	P-value
CT			0.01
Evidence of COPD (26)	11	15	
No evidence of COPD (183)	21	162	
Lesion location			
Lobe			0.032[a]
Upper (107)	10	97	
Middle (62)	15	47	
Lower (40)	7	33	
Maximal diameter,cm			0.01
<4 (86)	26	60	
4-6 (113)	5	108	
>6 (10)	1	9	
Length of needle through normal parenchyma, (cm)			0.011[a]
<4 (8)	1	7	
4-6 (167)	8	159	
>6 (34)	23	11	
Needle adjustments			0.01
1 (167)	10	157	
2 (35)	16	19	
3 (7)	6	1	
Pleural contact			0.005
Yes (22)	1	21	
No (187)	31	156	

[a]Statistically significant difference.

The risk factors of pulmonary hemorrhage included CT evidence of emphysematous lung or COPD,lesion size<4cm diameter,more depth of lesion>4 cm from skin,more needle adjustment contact ($p<0.05$),according to Table 4.

Table 4 show correlation between factors and hemorrhage..

Characteristic	Hemorrhage, n	Non-hemorrhage,n	P-value
Gender			0.06
Male	23	127	
Female	3	56	
Age		0.844	
17-49 (75)	8	67	
50-69 (112)	15	97	
70-86 (22)	3	19	
CT		0.007[a]	
Evidence of COPD (26)	8	18	
No evidence of COPD (183)	18	165	
Lesion location			
Lobe			0.565
Upper (107)	12	95	
Middle (62)	10	52	
Lower (40)	4	36	
Maximal diameter,cm			0.04
<4 (86)	17	70	
4-6 (113)	9	103	
>6 (10)	0	10	
Length of needle through normal parenchyma, (cm)			0.01
<4 (8)	0	8	
4-6 (167)	6	161	
>6 (34)	20	14	
Needle adjustments			0.01
1 (167)	2	165	
2 (39)	19	16	
3 (7)	5	2	
Pleural contact			0.323
Yes (22)	1	21	
No (187)	25	162	

[a]Statistically significant difference.

DISCUSSION :

Transthoracic percutaneous fine needle aspiration biopsy(FNAB)is a minimally invasive procedure that is an indispensable tool in the diagnosis of thoracic lesions. There are several known complications including pneumothorax,pulmonary hemorrhage,air embolism and tumor seeding[15-17]

Pneumothorax is the most common complication of needle aspiration of biopsy of the lung which is reported to occur in 17-26.6% of patients[15-17] The chest tube insertion rate is much lower ,ranging from 1% to 14% of patients[15-17] In the present study,the incidence of pneumothorax was 15.3%,with 1.5% (3/209) requiring chest tube drainage. The increased depth of the lesion from the skin(>4cm),smaller lesion (<4cm diameter),frequency of needle adjustments (>1),loss of pleura intact and CT evidence of emphysematous lung or (COPD) were risk factors for a pneumothorax ($p<0.05$). The higher incidence of pneumothorax is obsereved in middle lobe lesions (7.2%)($p=0.032$). It is probably due to more difficult to keep away from the interlobar pleura;if it is damaged, it is more likely to result in pneumothorax[17]

Austin and Cohen(1993)[14]demonstrated that lesions that contact pleura do not develop into pneumothorax[16] Yankelevits et al (1997) demonstrated lesions that were more than 30 mm away from the pleura or nodules smaller that 10 mm increased the frequency of pneumothorax. Fish et al[18] found that the pneumothorax rate was 46% in patients with pulmonary function test and chest radiograph showing obstructive airway disease compared with 7 % in patients with normal finding for both criteria.

Certain lesion characteristics also predispose patients to pneumothorax. In cases in which the lesion is in the chest wall,mediastinum,pleura,or subpleural lung and no aerated lung is traversed by the biopsy needle,the likelihood of pneumothorax is minimal[17]. Increased depth of the lesion from the skin or long needle path(>4cm)is associated with increased risk of pneumothorax[15-17]. Small lesion size also plays a role in the development of pneumothorax[15,17] Technical factors also affect the pneumothorax rate. The risk of pneumothorax increased with increased number of pleural puncture[21] and wider insertion angle of the needle,that is ,when the needle is inserted less perpendicular to the pleura[16].

Pulmonary hemorrhage is the second most common complication of needle biopsy of the chest, with reported frequency ranging from 4% to 27%[4] Hemothorax is exceeding rare,with an incidence of 0.092% in one study(19) Small lesion size and greater lesion depth or long biopsy path are associated with higher risk of bleeding[16-18]. In the present study,the incidence of pulmonary hemorrhage is 12.4%.. The results showed that small size (<4cm diameter),increased depth of the lesion from the skin (>4cm) , more needle adjustments and CT evidence of emphysematous lungs were poor predictive factors ($p<0.05$).

Khan MF et al found 27% of biopsy cases showed perifocal hemorrhage[22]. Intrapulmonary biopsy path longer than 4 cm, pleura penetrated twice during the puncture and lesion size <4 cm is strongly correlated with occurrence of perifocal hemorrhage. CT evidence of emphysema,perhaps because of the lack of effective tamponade by adjacent tissue[23]

Conces et al revealed rated of pulmonary hematoma and hemoptysis as 11% and 2%, respectively,with spontaneous resolution[14] In our study, the occurrence of pulmonary hemorrhage and hemoptysis was 12.4% and 2.4% respectively,with self-limted.

Air embolism is a rare but potentially fatal complication. In the large series of 9783 biopsies,there were only six cases(0.061%)of air embolism[19]. Sinner

reported two suspected cases in a series of almost 2700 cases[12]. Tumor seeding of t he pleura of chest wall along the needle track is an extremely rare complication with a reported of 0.012%-0.061% [19,20] No definitive risk factor related to needlesize,tumor size or tumor location has been indentified [20].

In the present study,no air embolism or tumor seeding were observed.

CONCLUSION:

Transthoracic percutaneous fine needle aspiration biopsy(FNAB)is a minimally invasive procedure that is an indispensable tool in the diagnosis of thoracic lesions. Pneumothorax and pulmonary hemorrhage are the most common complications. Most of the complications are spontaneous resolution. Only few needs more interventions. The characteristics of the lesion such as the middle lobe location,,,small size<4 cm diameter, depth of lesion from the skin>4cm, and evidence of COPD lungs are poor predictive factors. The biopsy technique include number of needle adjustment,,keep away from the interlobar pleura can help to prevent or minimize most potential complications.

REFERENCES :

1. Haaga JR,Alfidi RJ. Precise biopsy localization by computed tomography. Radiology 1976;118:603-607
2. Westcott JL. Percutaneous transtoracic needle biopsy . radiology 1988;169:593-601
3. Van Sonnenberg E,Lin AS,Deutsch AL,Mattrey RF. Percutaneous biopsy of difficult mediastinal ,hilar and pulmonary computed tomographic guidance and a modified coaxial technique. Radiology 1983;148:300-302
4. Stanley JH,Fish GD,Andriole JG,et al. Lung lesions : cytologic diagnosis by fine needle biopsy. Radiology 1987;162
5. Khouri, NF,Stitik FP,Erozan YS,et al. Transtoracic needle aspiration biopsy of benign and malignant lung lesions. Am J Roentgenol 1985;144:281-288
6. Li H,Boiselle PM,Shepard JO,Trotman-Dickenson B,McCloud TC. Diagnostic accuracy and safety of CT-guided percutaneous fine needle aspiration biopsy of t he lung. AJR 1996;109
7. Larscheid RC,Thorpe PE,Scott WJ. Percutaneous transthoracic needle aspiration biopsy: a comprehensive review and role in the diagnosis and treatment of lung tumors. Chest 1998;114:704-709
8. Tsukada H,Satou t,Iwashima A,Souma T. Diagnostic accuracy of CT-guided automated needle biopsy of lung nodule. AJR 2000;175:239-243
9. Perlmutt LM,Johnson WW,Dunnick NR. Percutaneous transthoracic needle aspiration;a review AJR 2001;152:451-455
10. Laurent F,Michel P,Latrabe V,de lara MT,Marthan R. pneumothorraces and chest tube placement after CT-guided transthoracic lungt biopsy using a coaxial technique. AJR 1999;172:1049-1053
11. Laurent F,labtrabe V,V ergier B,Michel P. Percutaneous Ct-guided biopsy of the lung:comparison between aspiration and automated cutting needles using a coaxial technique. Cardiovasc intervent Radiolo 2000;23:266-272
12. Sinner WN Complications of percutaneous transthoracic needle aspiration biopsy. Acta radiolo 1976;17:813-828
13. Tolly TL,Feldmeier JE,Czernecki D. Air embolism complicating percutaneous lung biopsy. AJR 1986
14. Austin JH,Cohen MB. Value of having a cytopathologist present during percutaneous fine needle aspiration biopsy of lung:report of 55 cancer patients and metaanalysis of the literature. AJR 12993;160:175-7

15. Covey AM,Gandhi R,Brody LA,Getrajdman G,Thaler HT,Brown KT. Factors associated with pneumothorax and pneumothorax requiring treatment after percutaneous lung b iopsy in 443 consecutive patients. J Vasc Interv Radiolo 2004;15:479-483
16. Saji H,Nakamura H,Tsuchida T,et al. The incidence and the risk of pneumothorax and chest tube placement after percutaneous CT-guided lung biopsy. Chest 2002;121:1521-1526
17. Yeaow KM,SU IH,Pan KT,et al. Rsik factors of pneummothorax and bleeding;multivariate analysis of 660 CT-guided coaxial cutting needle lung biopsies. Chest 2004;126:748-754
18. Fish GD,Stanley JH,Miller KS,Schabel SI,Sutherland SE. Postbiopsy pneumothorax:estimating thoe risk by chest resdiograph and pulmonary function tests. AJR 1988;150:71-74
19. Tomiyama BN,Yasuhara Y,nakajima Y,et al. C t-guided needle biopsy of lung lesions based on 9783 biopsies in Japan. Eur J Radiol 2006;59: 60-64
20. Ayar D,Golla B,Lee JY,Nath H. Needle-track metastases after transthoracic needle biopsy. J Thorac Imaging 1998;13:2-6
21. Moore EH,Shepard JO,MCLoud TC,et all. Positional precaution in needle aspiration lung biopsy. Radiology 1990;175:733-735
22. Khan MF,Straub R,Moghaddam SR,et al. Variables affecting the risk of pneumothorax and intrapulmonal hemorrhage in CT-guided transthoracic biopsy, Eur Radiolo 2008;18:1356-1363
23. Heyer CM,Reichelt S,Peters SA,Walther JW,Muller KM,Nicolas V. Computed tomography-navigated transthoracic core biopsy of pulmonary lesions:whick factore affect diagnostic yield and complication rates? Acad Radiolo 2008;15:1017-1026