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CT-guided fine-needle aspiration of lung nodules: effect on outcome of using coaxial technique and Immediate cytological evaluation

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PURPOSE

To evaluate the risk of pneumothorax during CT-guided fine-needle aspiration (FNA) of lung nodules with single needle and coaxial needle techniques and to assess the effect on diagnostic accuracy of immediate cytological examination of lung FNA samples.

MATERIALS AND METHODS

This prospective study analysed 53 patients undergoing transthoracic FNA biopsy of lung. 36 cases were performed by a radiologist using a coaxial technique, with 17 cases performed by a radiologist using a direct single-needle method. Effect of technique on occurrence of pneumothorax was recorded. FNA samples from all the patients in the study were examined immediately on-site by a cytologist or MLSO to determine whether sufficient aspirate had been obtained. Provisional diagnosis at immediate examination was compared to final diagnosis following full pathological evaluation.

RESULTS

Coaxial and non-coaxial groups were comparable for age and gender. Number of pleural passes was significantly lower in coaxial group (P< 0.01). Pneumothorax occurred in six (17%) of the 36 patients biopsied by coaxial technique, compared to four (24%) of the 17 patients by non-coaxial method (P= 0.55). Chest tube placement was required in four patients (11%) in the co-axial group, and two patients (12%) in the non-coaxial group (P= 0.85).

A provisional cytological diagnosis was recorded for 74% of the patients in the study. 83% of the provisional reports were accurate on comparison with full pathology report. Specimen size was sufficient in 81% of cases.

CONCLUSIONS

The use of coaxial technique for CT-guided lung FNA biopsy reduced the number of pleural passes but did not significantly reduce the occurrence of pneumothorax. Immediate cytological examination of FNA specimens provided an accurate provisional diagnosis in the majority of cases, and should be routinely employed.

INTRODUCTION

CT-guided fine needle aspiration (FNA) biopsy is a well-established diagnostic procedure used in the investigation of pulmonary nodules. Equipment and expertise required to perform this procedure are available in many hospital radiology departments. Cytopathological examination of specimen obtained from lung nodules by CT-guided FNA biopsy is an accurate and sensitive way of diagnosing malignancy[2,3]. During the procedure, a needle is inserted percutaneously through the chest wall under CT guidance in

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order to aspirate suitable specimen from the lung nodule for cytological analysis (Figure 1).

If a single needle technique is used, a pleural puncture must be performed each time FNA of the nodule is attempted. Coaxial biopsy systems enable multiple fine needle aspirates to be performed with a single pleural puncture. The purpose of this study was to examine the effect of coaxial needle technique on the occurrence of post-procedure pneumothorax. In many centres, immediate cytological examination is performed on-site in the radiology department by a cytopathologist or MLSO. The other purpose of this study was to assess the diagnostic accuracy of immediate cytological examination during CT-guided FNA lung biopsy.

MATERIAL AND METHODS

This prospective study involved 53 patients who had lung nodules suspicious of malignancy identified on CT imaging, and who were subsequently referred by consultant medical staff for CT-guided FNA biopsy. All procedures were performed at the Department of Radiology, Royal Victoria Hospital. The 53 patients presented sequentially over a period of 18 months. Written informed consent was obtained in all cases. 36 cases were performed by one consultant radiologist using a coaxial technique. The other 17 cases were performed by one consultant radiologist using a single needle technique.

A Greene (Cook, Bloomington, Ind) 22-gauge needle in a 19-gauge introducer needle was used by the radiologist performing FNA by coaxial technique. A Greene 22-gauge needle alone was used by the radiologist performing FNA by single needle technique. Local anaesthesia was administered by subcutaneous injection of 2% lignocaine. The procedure was performed with the patient in prone, supine or lateral decubitus position, depending on the location of the lesion.

Each patient had follow-up CT scan immediately after FNA biopsy to check for post-procedure pneumothorax. An erect chest radiograph was also obtained after FNA to detect pneumothorax. The number of patients developing post-procedure pneumothorax, and pneumothorax requiring pleural drainage was recorded.

A cytologist was present at 38 cases (72%), and a MLSO was present in the other 15 cases (28%). All specimens obtained were immediately smeared and stained. The adequacy of the sample for diagnosis was assessed by the cytologist or MLSO. Additional aspirates were obtained when original specimens were not considered sufficient for diagnosis. A provisional report was provided by the cytologist or MLSO, indicating the preliminary diagnosis when possible. The specimen was then taken to the cytopathology laboratory for full analysis. The accuracy of the provisional report in comparison to the final cytopathology report was recorded.

RESULTS

There was no statistically significant difference in age between patients in the two groups (Table 1), with a mean age of 61.9 years for patients undergoing FNA by coaxial technique and a mean age of 66.3 years for patients having FNA by single needle method. There was also no significant difference in gender ratio between patients in the two groups.

The mean duration of the procedure was 23.5 min for patients in the coaxial group and 19.9 min for patients in the single needle group, which was not significantly different. The number of pleural passes per case was significantly lower when the coaxial technique was employed. The median number of pleural passes per case was one in the coaxial group, and two in the single needle group. The median number of aspirates per case was lower when FNA biopsy was performed by the coaxial technique, but this was of borderline significance only (p=0.05).

Each patient was checked for post-procedure pneumothorax by CT-imaging and chest Xray. CT is more sensitive in the detection of small pneumothoraces. Table 2 shows that nine (25%) of the 36 cases performed by coaxial technique were complicated by post-procedure pneumothorax (identified on CT or chest Xray), compared to four (24%) of the 17 cases performed by single needle technique. This difference was not statistically significant. six (17%) of the 36 patients in the coaxial group developed pneumothorax sufficient to be detected on post-procedure chest xray, in comparison to four (24%) of patients in the single needle group. This difference was again not statistically significant. There was no significant difference in the number of patients with post-procedure pneumothorax requiring pleural drainage, with four cases (11%) in the coaxial group and two cases (12%) in the

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single needle group.

Immediate cytological evaluation of the FNA specimens was performed in all 53 cases to confirm adequacy of specimen cellularity. Table 3 shows that the cytologist was able to make a preliminary diagnosis in 39 (74%) of the 53 cases, but was unable to reach a preliminary diagnosis in 14 cases (26%). The final cytopatholgy report was available in 48 of the cases. The specimen subsequently received by the cytology laboratory was deemed to be adequate analysis in 39 (81%) of the 48 cases. It was possible to compare the preliminary diagnosis made at immediate cytology to the final laboratory report in 36 of the cases. The preliminary diagnosis was accurate in comparison to the final report in 31 (86%) of the 36 cases.

Table 4 shows the accuracy of immediate cytological evaluation of FNA specimens in the detection of malignancy. In comparison to the final laboratory report, the preliminary diagnosis had a sensitivity of 90.0% and a specificity of 83.3% in the detection of malignancy. There was a positive predictive value of 96.4% and a negative predictive value of 62.5%, in the detection of malignancy.

TABLE I

Comparison of Coaxial Group and Single Needle Group in Relation to Demographic and Procedure-related Variables

Parameter	Coaxial group	Single needle group	P Value
Mean age	61.9 ± 14.4	66.3 ± 11.6	0.75
Male/Female ratio	0.8	0.9	0.91
Procedure duration (min)	23.5 ± 8.3	19.9 ± 8.5	0.77
Number of pleural passes	1 ± 0.3	2 ± 0.7	<0.01
Number of aspirates	1 ± 1.0	2 ± 0.7	0.05

TABLE II

Occurrence of Pneumothorax Following CT-guided Lung FNA Biopsy

Pneumothorax	Coaxial group	Single needle group	P Value
Pneumothorax on CT or Chest Xray	9 (25%)	4 (24%)	0.92
Pneumothorax on Chest Xray	6 (17%)	4 (24%)	0.55
Pneumothorax requiring pleural drainage	4 (11%)	2 (12%)	0.85

TABLE III

Specimen Adequacy and Preliminary Diagnosis with Use of Immediate Cytological Evaluation

Immediate cytology	% of cases
Specimen adequate for full laboratory analysis (n=48)	81
Preliminary diagnosis made(n=53)	74
Preliminary diagnosis accurate(n=36)	86

TABLE IV

Detection of Malignancy by Immediate Cytological Evaluation

Immediate cytology: Detection of malignancy	% rate
Sensitivity	90.0
Specificity	83.3
Predictive value of positive result	96.4
Predictive value of negative result	62.5

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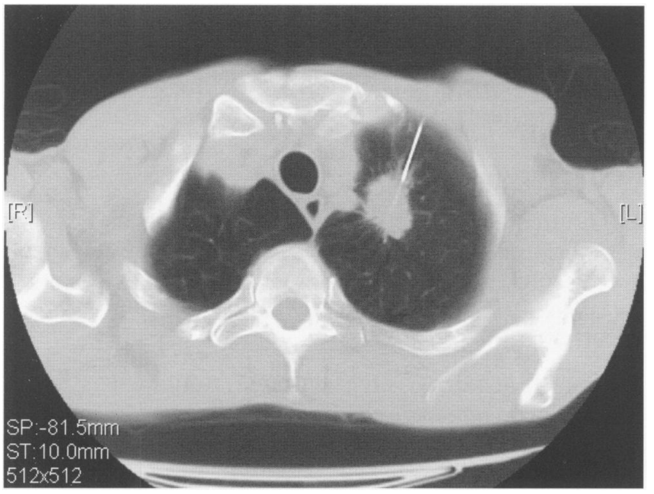

Fig 1. CT image obtained during FNA biopsy of a solitary left upper lobe lung nodule in a 53 year old male patient. This axial image shows percutaneous insertion of FNA biopsy needle through anterior chest wall, with patient in supine position.

DISCUSSION

CT-guided FNA lung biopsy is a procedure of low mortality and limited morbidity[5]. Pneumothorax is by far the most frequent complication of CT-guided lung FNA, followed by haemoptysis and pulmonary haemorrhage[1]. Rare complications include seeding of malignant cells into needle tract, lung torsion, empyema, systemic air embolism and pericardial tamponade[2]. The rate of pneumothorax after CT-guided lung FNA biopsy reported in medical literature ranges from 7.6% - 46%[1]. The recently published British Thoracic Society guidelines for radiologically guided lung biopsy recommend that operators should try to achieve the lowest quoted complication rates, ie pneumothorax in 20.5% of biopsies[7]. Pneumothorax is usually detected by CT imaging immediately after FNA, or on post-procedure chest Xray. Most patients developing pneumothorax are managed conservatively, but a proportion need pleural drainage. The percentage of patients requiring pleural drainage after biopsy in reported studies varies between 3.3% and 15 %[7]. Various articles have shown that patients with emphysema and other respiratory disease are more likely to develop pneumothorax after CT-guided lung FNA, and more frequently require pleural drainage[1,2]. Lesion size and location have also been reported to correlate with rate of post-procedure pneumothorax[1,2,3]. 13 of the 53 patients in this study developed post-procedure pneumothorax, giving an overall rate of 24.5%. This compares favourably to the range reported in medical literature from similar studies and the target level recommended in the British Thoracic Society guidelines[1,7]. The overall rate of post-procedure pneumothorax requiring pleural drainage was 11.3% (6 of 53 cases), which again lies within the range reported in other studies.

The influence of other procedure-related variables on development of pneumothorax has also been investigated. If a single needle technique is used, a pleural puncture must be performed each time FNA of the nodule is attempted. Coaxial biopsy systems enable multiple fine needle aspirates to be obtained via an introducer needle which remains within lung parenchyma for a variable time. Multiple FNA biopsies can therefore be performed with a single pleural puncture. As expected, the results of this study show that the number of pleural passes performed was significantly lower in cases using the coaxial technique compared to the single needle technique. Although use of coaxial technique reduces the number of pleural punctures, several studies have failed to show significant correlation between the number of pleural passes and the pneumothorax rate[2,3,6]. The results of our study further support this conclusion, as there was no significant difference in the total rate of pneumothorax or the rate of pneumothorax requiring pleural drainage between the coaxial and single needle groups.

Analysis of the results shows that patients undergoing CT-guided lung FNA by coaxial technique were comparable to patients in the single needle group in terms of age and gender. There was also no significant difference in procedure duration between the two groups. The number of aspirates per case was lower in patients having FNA lung biopsy by coaxial technique, but this was only of borderline significance. A number of potential confounding variables in development of post-procedure pneumothorax were not investigated in this study. These include the size of the lung nodule, the location and depth of the nodule, and coexistent respiratory disease such as emphysema. However, all patients undergoing CT-guided lung FNA biopsy by the two radiologists during the 18 month period were included in the study without exclusion. The potential confounding effect of other variables is therefore likely to be small.

The specimen obtained by CT-guided FNA lung

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biopsy undergoes cytological examination to establish if malignancy is present. The specimen must be of adequate cellularity for diagnostic assessment. Preparation and staining of the specimen is performed in the cytopathology laboratory prior to full assessment. In many centres, immediate cytological examination is performed on-site in the radiology department by a cytopathologist or MLSO. There are several perceived benefits of immediate cytology. Initial examination of the specimen can indicate whether it is of sufficient cellularity, so that FNA biopsy can be repeated immediately if specimen is inadequate[4,5]. The British Thoracic Society guidelines indicate it is likely that immediate microscopic examination reduces the number of biopsy samples required to achieve a diagnosis[7]. A provisional diagnosis can be made, helping to guide patient management more quickly. Immediate cytology may also indicate whether additional specimen is required for ancillary studies, such as cytogenetics.

In this study, a cytologist or MLSO was available to perform immediate cytological evaluation of the specimen obtained by CT-guided lung FNA in all 53 cases. This enabled FNA to be repeated at time of procedure if specimen was inadequate. The use of immediate cytology resulted in a specimen adequate for full laboratory analysis in a large majority (81%) of cases. The cytologist or MLSO was able to provide a preliminary diagnosis at immediate cytology in most cases (74%). When a preliminary diagnosis was made, this proved to be accurate in comparison to the final cytopathology report in 86% of cases. This study also demonstrates that immediate cytological examination of specimens during CT-guided lung FNA biopsy has relatively high sensitivity and specificity in the detection of malignancy. This highlights the potential role of immediate cytology in guiding patient diagnosis and management more rapidly.

In conclusion, our results indicate that the use of a coaxial technique during CT-guided lung FNA biopsy reduces the number of pleural passes per case, but does not significantly reduce the occurrence of pneumothorax. The overall rate of pneumothorax was within the range reported in other similar studies. Immediate cytological examination of FNA specimens provides an accurate provisional diagnosis in the majority of cases, and results in a high rate of specimens adequate for full laboratory analysis. Therefore, immediate cytology should be routinely employed during CT-guided FNA biopsy of lung, whenever available.

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