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Usefulness of technetium-99m hexamethylpropylene amine oxime lung scan to detect inhalation lung injury of patients with pulmonary symptoms/signs but negative chest radiograph and pulmonary function test findings after a fire accident—a preliminary report

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Objective: In this study, we employed technetium-99m hexamethylpropylene amine oxime (^{99m}Tc HMPAO) lung scan to detect inhalation lung injury of patients after a fire accident. ***Methods:*** Ten healthy men for controls and 10 male patients with pulmonary symptoms/signs from a fire accident were enrolled in this study for comparison. ^{99m}Tc HMPAO lung scan was performed in each control and patient, as well as the degree of pulmonary vascular endothelium damage was represented as lung/liver uptake ratios (L/L ratio). All of the controls and patients had no smoking histories. None of the controls and patients had positive findings of plain chest radiograph (CXR) and pulmonary function test (PFT). ***Results:*** The results showed that significantly higher L/L ratio in the 10 patients (0.53 ± 0.07) than in the 10 controls (0.30 ± 0.07) (the p value < 0.05). Using a cut-off value of 0.40, all of the 10 patients had abnormally increased L/L ratios. ***Conclusions:*** We conclude that ^{99m}Tc HMPAO lung scan has the potential to be a sensitive, objective and noninvasive method to detect inhalation lung injury of patients with pulmonary symptoms/signs but negative CXR and PFT findings after a fire accident.

Key words: technetium-99m hexamethylpropylene amine oxime, inhalation lung injury, fire accident

INTRODUCTION

SMOKE OR HEAT INHALATION after a fire accident usually causes parenchymal lung injury results in interference with gas exchange.[1–3] This often leads to acute pulmonary insufficiency, which is a major cause of morbidity and mortality in fire victims.[1–3] Early reports suggested that the plain chest radiograph (CXR) and pulmonary function test (PFT) were of little value in the early diagnosis and management of patients with inhalation lung injury after a fire accident.[4–6] However, there is still a lack of the sensitive, objective and noninvasive method to detect inhalation lung injury of patients from a fire accident. Technetium-99m hexamethylpropylene amine oxime (^{99m}Tc HMPAO) lung scan has been used to assess mild lung injury in various diffuse infiltrative lung disease, which are presented as the degree of pulmonary vascular endothelium damage.[7,8] Therefore, in this study, we tried to use ^{99m}Tc HMPAO lung scan to detect inhalation lung injury of patients with pulmonary symptoms/signs, since either chest radiograph (CXR) or pulmonary function test (PFT) resulted in little value after a fire accident.

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MATERIALS AND METHODS

Subjects

Ten male patients (aged from 30–49 years old, mean: 40.6 ± 6.3 years old) with pulmonary symptoms/signs such as dyspnea and/or cough with/without sputum following a fire accident in a supermarket were sent to the emergency room for further evaluation. However, to estimate the amount of inhaled smoke and materials of combusted in the fire is difficult. Patients with a history of smoking or previous lung disease were excluded. No patient's occupation was firefighter or daily exposure to smoke. In addition, 10 healthy men without smoking histories were included as normal controls. All of the study subjects including controls and patients had negative CXR and PFT findings. Negative CXR findings excluded pleurisy, atelectasis, pulmonary edema, acute pneumonitis, diffuse interstitial disease and diaphragmatic dysfunction with loss of lung volume.[9] Comprehensive PFT included forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and diffusion capacity by a single breath CO method (DLco). Above the 80 percent of the predicted value was considered negative findings. ^{99m}Tc HMPAO lung scan, CXR, and PFT were performed within 24 hours. The informed consent was obtained for the participating patients.

^{99m}Tc HMPAO Lung Scan

Anterior planar image of ^{99m}Tc HMPAO lung scan including all of the lungs and most of the liver was obtained

Table 1 Detailed data of controls and patients

Case No.	Controls		Patients			
	Age (years)	Lung/Liver ratio	Age (years)	Lung/Liver ratio		Hospitalization /Days
1	30	0.24	31	0.46	*	No
2	34	0.32	33	0.66	*	Yes/2
3	35	0.38	34	0.48	*	No
4	37	0.39	35	0.49	*	No
5	40	0.19	39	0.54	*	Yes/3
6	44	0.34	41	0.52	*	No
7	45	0.26	42	0.42		No
8	46	0.23	43	0.62	*	Yes/3
9	46	0.31	45	0.50	*	No
10	49	0.37	48	0.55	*	Yes/2
Max.	49	0.39	48	0.66		
Min.	30	0.19	31	0.42		
Mean	40.6	0.3	39.1	0.53		
SD	6.3	0.07	5.6	0.07		

*: abnormal results, ratio > 0.30 + 0.07 × 2 = 0.44

Table 2 Detailed data of pulmonary function tests in controls and patients

Case No.	Controls			Patients			
	FVC % predicted	FEV_1 % FVC	DLco %	Symptoms & Signs	FVC % predicted	FEV_1 % FVC	DLco %
1	91	88	105	dyspnea, cough	94	83	104
2	90	91	110	cough, dyspnea	108	90	112
3	110	85	95	cough, sputum	91	83	93
4	103	93	90	cough, sputum	98	94	95
5	88	87	98	cough, sputum	102	99	105
6	96	96	103	dyspnea, sputum	93	91	99
7	97	93	121	cough	90	85	101
8	95	89	93	cough, sputum	110	97	109
9	92	90	107	cough, dyspnea	91	89	96
10	105	94	102	dyspnea, cough	101	92	90
Max.	110	96	121		110	99	112
Min.	88	85	90		90	83	90
Mean	96.7	90.6	102		97.8	90.3	100
SD	7.2	3.4	9.1		7.2	5.5	7.1

10 minutes after intravenous injection of 740–925 MBq (20–25 mCi) of ^{99m}Tc HMPAO. ^{99m}Tc HMPAO lung scans were acquired using a gamma camera interfaced with a computer. Analog images and computerized images with an accumulation of 500 k counts were obtained. Regions-of-interests (ROI) were drawn over the midportion of the right lung and the highest activity area of the liver parenchyma was selected and lung/liver uptake ratios (L/L ratio) were calculated to represent the degree of pulmonary vascular endothelium damage based on the published method.[8]

Statistical Analysis

The statistical difference of mean lung/liver uptake ratio between the 10 controls and 10 patients was analyzed by a nonparametric Mann-Whitney U test. If the p value < 0.05, the statistical difference was considered as significant.

RESULTS

Detailed data of lung/liver uptake ratio in controls and patients are shown in Table 1. Detailed data of pulmonary function tests in controls and patients included FVC, FEV_1, and DLco were listed in Table 2. The L/L ratio was 0.30 ± 0.07 in the 10 normal controls and 0.53 ± 0.07 in the 10 patients. The difference was significant with a p value of less than 0.05. Using a cut-off value of 0.40 (all of 10 normal controls had L/L ratios below 0.39), all of the 10 (100%) patients had an abnormally increased L/L ratio. Four patients were admitted for further treatments with 2–3 days of hospitalization. The L/L ratio of the 4 patients with hospitalization was higher (0.59 ± 0.06) than those of the 6 patients without hospitalization (0.48 ± 0.03). However, the difference is not significant (p value > 0.05). Following-up of 3 months after the 10 patients were discharged, no patient had pulmonary symptoms/signs and sequels.

DISCUSSION

^{99m}Tc HMPAO is a cyclic amine as a lipophilic brain imaging agent used for the diagnosis of stroke and dementias. Elevated pulmonary uptake of this agent has been demonstrated in patients with pulmonary edema[10] and in smokers.[11] Its localization is presumably in the pulmonary vascular endothelium.[12] However, in this study, the mechanism of increased uptake of ^{99m}Tc HMPAO in the lungs of patients with pulmonary symptoms/signs but negative CXR and PFT findings after a fire accident is unknown. It may be related to dysfunction of vascular endothelial cells or dysfunction of amine metabolism in the injured endothelium.[13]

The value of the CXR in the evaluation of the inhalation lung injury in fire victims is debatable. Previous studies suggested that the value of CXR in the diagnosis and management of patients after acute smoke inhalation is limited.[4–6] In our study, only the patients with negative CXR findings were included. Therefore, we conclude that CXR is not a sensitive modality to detect mild inhalation lung injury after a fire accident. Abnormality in CXR may not be seen until a severe complication such as atelectasis, alveolar edema, or bronchopneumonia develops. Because only PFT after fire accident could be done in this study, assessment of the influence of inhalation lung injury on PFT due to a fire accident is very difficult. However, compare with a normal database, only the patients with negative PFT findings (above 80% of normal predicted values) were included in this study. Therefore, our preliminary results suggest that PFT may not be a sensitive test to detect mild inhalation lung injury after a fire accident.

Although the number of patients in our study was too small to make a conclusion, our findings show significantly increased L/L ratios in patients with pulmonary symptoms/signs but negative CXR and PFT findings after a fire accident. We have to consider that the conventional CXR and PFT are not sensitive modalities to detect mild inhalation lung injury after a fire accident. In conclusion, ratio of lung/liver uptake of ^{99m}Tc HMPAO served as an additional or alternative way, independent of CXR and PFT seems to be a sensitive, objective and noninvasive method to early detect mild inhalation lung injury of patients after a fire accident. However, future investigations such as broncho-alveolar lavage and cytological examination in a larger series of case numbers with longer follow-up and their outcomes should be encouraged to confirm our findings.

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