SUBPLEURAL CURVILINEAR SHADOW IN INTERSTITIAL PULMONARY DISEASES

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Chest radiographic findings in pulmonary asbestosis have been studied,[1,2] and pulmonary asbestosis is mainly diagnosed by irregular opacities on chest radiographs.[3] However, computed tomographic (CT) findings have not been studied to the same extent as radiographic findings. In our previous study,[4] we revealed a line parallel to the inner chest wall in the lung on high-resolution CT alone, and we called it subpleural curvilinear shadow (SCLS, Figure 1).

In this study, to analyze the significance of the SCLS in pulmonary asbestosis, we studied the prevalence rate of the SCLS in several interstitial pulmonary diseases and in asbestos workers with normal chest roentgenograms.

MATERIALS (Table I)

Twenty-two patients with pulmonary asbestosis (ASBESTOSIS) were examined. They were 21 men and a woman ranged in age from 40 to 64 years (mean; 53 years) and ranged in duration from the first exposure to asbestos from 15 to 43 years (mean; 30 years). By ILO classification, 12 of ASBESTOSIS had category 1 (1/0, 1/1, 1/2), 7 had category 2 (2/1, 2/2, 2/3), and 3 had category 3 (3/2, 3/3, 3/+) disease. For the controls, 33 patients with idiopathic pulmonary fibrosis (IPF), 23 patients with interstitial pneumonia due to collagen vascular diseases (CVD), and 102 patients with lung cancer admitted to our hospital during the last one year (LC) were examined. The IPF group consisted of 29 men and 4 women ranged in age from 49 to 78 years (mean; 66 years). The CVD group included 11 patients with rheumatoid arthritis (7 men and 4 women), 6 with progressive systemic sclerosis (a man and 5 women), 3 women with polymyositis or dermatomyositis, 2 women with mixed connective tissue disease, and a woman with systemic lupus erythmatosus. They were ranged in age from

Table I
Characteristics of the Materials

	n (male)	age (range) [yrs]	exposure (range) [yrs]
ASBESTOSIS	22 (21)	53 (40-64)	30 (15-43)
IPF	33 (29)	66 (49-78)	-
CVD	23 (8)	55 (35-83)	-
L C	102 (83)	63 (32-82)	-
WORKERS	22 (18)	49 (35-61)	27 (14-43)

Note-- ASBESTOSIS; patients with pulmonary asbestosis
IPF; patients with idiopathic pulmonary fibrosis
CVD; patients with interstitial pneumonia due to collagen vascular diseases
LC; patients with lung cancer
WORKERS; current asbestos workers with normal chest roentgenograms
exposure; duration from the first exposure to asbestos dust

Figure 1. Subpleural curvilinear shadow (SCLS).

35 to 83 years (mean; 55 years). The LC group consisted of 83 men and 19 women ranged in age from 32 to 82 years (mean; 63 years).

Twenty-two current asbestos workers (WORKERS) with normal chest roentgenograms (ILO category 0) were also examined. They were 18 men and 4 women ranged in age from 35 to 61 years (mean; 49 years) and ranged in duration of exposure to asbestos from 14 to 43 years (mean; 27 years).

METHODS

A GE *CT/T* 8800 whole-body scanner (General Electric Medical Systems, Milwaukee, Wis.) was used for this study. High-resolution CT scanning (target reconstruction of the bone detail) was performed in all cases. The scan time was 9.6 seconds and section thicknesses were 1.5 mm or 2 mm. The window level was set at −550 and the window width at 2000 Hounsfield units. In determining the presence of SCLS, an SCLS shorter than 1 cm in length was excluded.

In the first study, the prevalence rates of SCLS were compared among several interstitial pulmonary diseases (ASBESTOSIS, IPF and CVD) and non-interstitial pulmonary disease (LC). In LC, the lung regions without tumor were examined.

In the second study, following the evaluation of the SCLS prevalence rate in WORKERS, sex, age, duration of asbestos

exposure, and smoking habit were compared between WORKERS with and without SCLS.

In the third study, CT findings including SCLS and honey comb shadow (HC) were compared with ILO classification in both ASBESTOSIS and WORKERS. CT findings were classified to five types (Figure 2) according to our previous study;[4]; type 0 has no SCLS and HC, type I has SCLS without other pulmonary abnormality or with abnormality located only peripherally, type II has HC located in the subpleural zone, type III has HC spreading intermediate between types II and IV, and type IV has HC spreading to the hilar region.

RESULTS

In the first study (Table II), we observed SCLS in 17 (77%) of 22 cases with pulmonary asbestosis. SCLS was also detected 7 (21%) of 33 patients with IPF and 9 (39%) of 23 patients with CVD. But in LC, SCLS was not detected. The SCLS prevalence rate in ASBESTOSIS was statistically higher than in IPP and in CVD ($p < 0.001$).

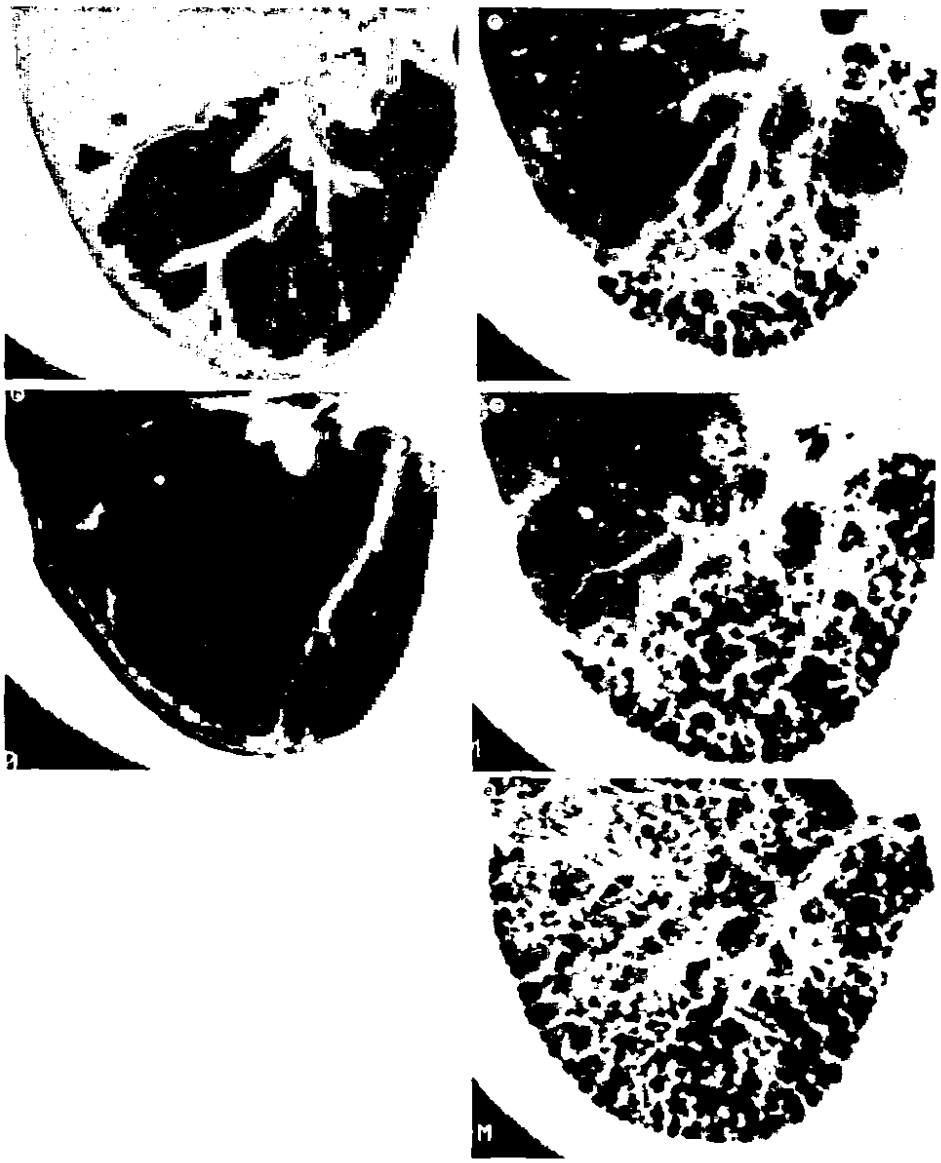

Figure 2. CT classification.
- a: type 0; no SCLS and no honey comb shadow (HC)
- b: type I; SCLS without other pulmonary abnormality or with abnormality located only peripherally
- c: type II; HC located in the subpleural zone
- d: type III; HC spreading intermediate between types II and IV
- e: type IV; HC spreading to the hilar region

In the second study (Table III), we observed SCLS in 7 (33%) of 22 cases in spite of their normal chest roentgenograms. And there were statistically no differences between WORKERS with and without SCLS in sex, age, duration of asbestos exposure, and smoking habit.

In the last study (Table IV), the relationship between ILO and CT classification in both ASBESTOSIS and WORKERS were evaluated. Of the 3 patients with ILO classification category 3 and CT classification type IV, 2 patients without SCLS had wide spreading HC from their lower lobes to their apices. Excluding these 2 severe cases, the SCLS prevalence rates were increasing in proportion to ILO classification.

DISCUSSION

In our previous study,[4] radiologic-pathologic correlation was described in one postmortem lung sample. The patient was a 55-year-old man with pulmonary asbestosis (ILO category 1). He had the SCLS in the right lower lobe. He died of respiratory failure 3 months later, and an autopsy was performed. It was made clear that the structure of SCLS was consisted of peribronchiolar fibrotic thickening with anthracosis joined by flattening and collapse of the alveoli with fibrosis. In other words, SCLS had a histologic pattern of fibrosing bronchiolo-alveolitis. This histologic finding is characteristic of pulmonary asbestosis, especially fibrosing bronchiolitis is known to be initial change of pulmonary asbestosis.

Following our previous study, several studies of high-resolution CT findings about pulmonary asbestosis were reported. Friedman et al. made use of SCLS for one of the criteria to diagnose pulmonary asbestosis.[7] Aberle et al. also reported SCLS (they called it "curvilinear subpleural line") was observed in 28% of 29 patients with pulmonary asbestosis.[5]

In the first study, we were able to observe SCLS not only in pulmonary asbestosis (ASBESTOSIS) but also in idiopathic pulmonary fibrosis (IPF) and interstitial pneumonia due to collagen vascular diseases (CVD). But no SCLS were detected in lung cancer (LC). From this results, the SCLS on high-resolution CT seemed one of the findings of interstitial pulmonary diseases. However, the prevalence rate of SCLS was markedly higher in ASBESTOSIS than in IPF and in CVD, and so the SCLS was supposed to be a more characteristic finding in ASBESTOSIS.

In the second study, we observed similar SCLS in one-third of current asbestos workers (WORKERS). They had been exposed to asbestos dust during 27 years in average but they had no findings of pulmonary asbestosis on their chest roentgenograms. And in the next study the backgrounds were compared between WORKERS with and without SCLS. But there were no differences between them. The cause of appearance of SCLS seemed not only the length of duration of asbestos exposure or smoking habit, but also individual constitution of each person and so on.

In the last study including ASBESTOSIS and WORKERS, the SCLS prevalence rates were increasing in proportion to ILO classification. These results supported the hypotheses that the SCLS was one of the common findings in pulmonary asbestosis and that the SCLS shown in asbestos workers with normal chest roentgenograms was an early change of pulmonary asbestosis. In our histologic survey,[4] the structure of SCLS was also compatible to the initial change of pulmonary asbestosis.

From the results mentioned above, we concluded that SCLS on high-resolution CT scan was useful for early detection of pulmonary asbestosis in asbestos workers.

Table II

Prevalence Rate of SCLS in Several Interstitial Pulmonary Diseases

	n	SCLS (%)
ASBESTOSIS	22	17 (77)
IPF	33	7 (21)*
CVD	23	9 (39)*
L C	102	0 (0)

Note-- * p<0.001 against ASBESTOSIS

REFERENCES

1. Souter, C.A., Simon, G., Turner-Warwick, M.: The Radiology of Asbestos-Induced Disease of the Lungs. *Br. J. Dis. Chest* 68:235-252 (1974).
2. Selikoff, I.J., Lee, D.H.K.: *Asbestos and Disease*, pp. 157-164. Academic Press, New York (1978).

Table III

Comparison of Background between Asbestos Workers with and without SCLS

	n	male (%)	age	exposure	smoker (%)
SCLS (-)	15	12 (80)	49 ±5	27 ±7	9 (60)
SCLS (+)	7	6 (86)	49 ±8	28 ±9	6 (86)

Note-- smoker; both current smokers and exsmokers

Table IV

Relationship between ILO and CT Classification in Patients with Pulmonary Asbestosis and Asbestos Workers

C T classification	ILO classification 0	1	2	3	total
type 0	14 (0)	1 (0)			15 (0)
I	7 (7)	6 (6)			13(13)
II	1 (0)	4 (2)	4 (4)		9 (6)
III		1 (1)	3 (3)		4 (4)
IV				3 (1)	3 (1)
total	22 (7)	12 (9)	7 (7)	3 (1)	44(24)

Note-- Numbers in parentheses indicate patients with SCLS

3. *International Labour Office.* ILO International Classification of Radiographs of Pneumoconiosis. Geneva (1980).
4. Yoshimura, H., Hatakeyama, M., Otsuji, H., Maeda, M., Ohishi, H., Uchida, H., Kasuga, H., Katada, H., Narita, N., Mikami, R., Konishi, Y.: Pulmonary Asbestosis; CT Study of Subpleural Curvilinear Shadow. *Radiology* 158:653-658 (1986).
5. Craighead, J.E., Abraham, J.L., Churg, A.: The Pathology of Asbestos-Associated Diseases of the Lungs and Pleural Cavities; Diagnostic Criteria and Proposed Grading Schema. *Arch. Pathol. Lab. Med.* 106:544-576 (1982).
6. Green, F.H.Y., Attfield, M.: Pathology Standards for Asbestosis. *Scand. J. Work Environ. Health* 9:162-168 (1983).
7. Friedman, A.C., Fiel, S.B., Fisher, M.S., Radecki, P.D., Lev-Toaff, A.S., Caroline, D.P.: Asbestos-Related Pleural Disease and Asbestosis,; A Comparison of CT and Chest Radiography. *A.J.R.* 150:269-275 (1988).
8. Aberle, D.R., Gamsu, G., Ray, C.S., Feuerstein, I.M.: Asbestos-Related Pleural and Parenchymal Fibrosis; Detection with High-Resolution CT. *Radiology* 166:729-734 (1988).

Proceedings of the VIIth International Pneumoconioses Conference *Part*
Transactions de la VIIe Conférence Internationale sur les Pneumoconioses *Tome*
Transaciones de la VIIa Conferencia Internacional sobre las Neumoconiosis *Parte*

II

Pittsburgh, Pennsylvania, USA—August 23–26, 1988
Pittsburgh, Pennsylvanie, Etats-Unis—23–26 aout 1988
Pittsburgh, Pennsylvania EE. UU—23–26 de agosto de 1988

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November 1990

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DHHS (NIOSH) Publication No. 90-108 Part II