Abstract

Objectives: To study the observer agreement in several asbestos-related pleural abnormalities and to define criteria to discriminate between pleural changes in workers with occupational disease, and those in controls. Methods: Pleural abnormalities in spiral computed tomography of 602 construction workers with asbestosis or bilateral pleural plaques and 49 controls were reviewed by three radiologists using structured forms. Results: Intra- and inter-observer agreement (weighted kappa) was 0.4 or better with regard to the calcification, extent and thickness of pleural disease. These factors all correlated positively with the duration of asbestos exposure. There were significant differences in these pleural changes between the workers (mean extent per side 83 cm²) and controls (mean extent per side 40 cm²). Of the controls, 84% showed pleural lesions with an estimated extent of 10 cm² or more, bilateral in 64%. The extent of 45 cm² in pleural disease was the best value for discriminating between the controls and diseased workers, with a sensitivity of 82% and a specificity of 66%. The degree of pleural calcification, however, was the best discriminator between these groups, but quantitative methods are necessary for its use in the diagnostics of individuals. Conclusions: The extent, calcification and thickness were well-repeatable indicators of benign pleural pathology and thus their use in future classification systems in computed tomography is recommended. In our material, the extent of 45 cm² and the degree of calcification were helpful in discriminating between pleural changes in workers with occupational disease, and those in controls who also presented marked pleural pathology.

Keywords: Observer bias · Classification · Diagnostic imaging · Occupational exposure · Mass screening · Occupational disease · Thorax

Introduction

Benign pleural abnormalities are the most common manifestations of asbestos exposure. These abnormalities include pleural thickening, either discrete plaques or diffuse thickening; rounded atelectases; and benign exudative effusions (Rosenstock and Hudson 1987). Discrete plaques, especially when bilateral and calcified, are considered highly specific for asbestos exposure (Gevenois et al. 1998). The general existence of these findings in the typical, elderly, Finnish population (Zitting 1995) complicates the diagnosis of occupational pleural disease. Diffuse pleural thickening is less specific and may have various aetiologies, including connective-tissue disease and drug exposure (Pfitzenmeyer et al. 1996). An international working group for the harmonisation of the computed tomography (CT) classification of pneumoconioses sometimes finds it difficult to distinguish between these entities (K. Hering, personal communication).

The standard International Labour Office (ILO) classification for pneumoconiotic changes using conventional radiography has become well established (ILO 1981). In recent years CT has gained importance in occupational medicine. It is superior to radiographs both in sensitivity and specificity when evaluating pleural abnormalities (Friedman et al. 1988). At present, an international classification of CT findings of pneumoconioses is lacking, and developing a standardised method of classification for CT seems necessary (Kraus et al. 1996).

We wanted to study the repeatability of different asbestos-related pleural changes, to identify potential
variables to be included in future international classifications of CT findings. In addition, our aim was to clarify which changes most clearly distinguished between construction workers with occupational disease, and controls. The study is a part of the national asbestos programme to improve the diagnostics of asbestos-related diseases.

**Subjects and methods**

Exposed workers

A previous study among 18,900 asbestos-exposed persons had identified 2,857 persons with asbestos-related occupational disease (Koskinen et al. 1996, 1998). Smokers (n = 642) and willing to participate (n = 602) were included. There were 85 cases of asbestosis and 601 cases of bilateral pleural plaques. Smoking was not an inclusion criterion for the patients with asbestosis. 20 of them were non-smokers. Five-hundred and ninety-one men and 11 women, mean age 63 (38–81) years, were actually enrolled in the study, most being occupationally exposed to asbestos for more than 20 years (mean 26) and having smoked for 24 pack-years on average.

The patients were personally interviewed by a standardised questionnaire including questions on smoking habits and occupational history. All were construction workers. They had installed heat and fire insulation or asbestos-containing walls and ceiling panels, or had used asbestos paints, putties and fillers. Some had dismantled asbestos-containing materials or cleaned areas where asbestos was present. This material was used also to screen for lung cancer that will be reported later.

Controls

Fifty willing controls were recruited, but one of them was later excluded due to apparent pulmonary metastatic disease which was screened for in each case. The controls were male patients (inclusion age 50–75 years) submitted to chest CT at the university hospital due to the suspicion or control of extrathoracic malignancies. All had smoked for over 10 years. A previous anticancer drug therapy (due to its potential to induce lung fibrosis) and an anamnestic asbestos exposure (reported by the patient in a brief interview prior to the CT examination) were exclusion criteria. However, in a detailed retrospective interview potential exposure could not be ruled out in 30 of these controls, due to several years working in the construction industry (four persons) or in a shipyard (two persons), or due to a limited occupational or free-time exposure, or to the failure to contact the person (group 2 = possibly exposed controls). Nineteen people most likely had no asbestos exposure (group 1 = unlikely exposed controls).

The study protocol was accepted by the local ethical committee (in accordance with the ethical standards laid down in an appropriate version of the 1964 Declaration of Helsinki).

Imaging

The workers were imaged from the apical lungs to the costophrenic angle with a Picker PQ 2000 scanner (125 mA, 140 kV, 10 mm collimation, pitch 1.5) and were lying in the supine position with full inspiration. Unenhanced images were reconstructed as 10-mm slices using a standard reconstruction algorithm and were printed at two window settings, one appropriate for viewing the lung parenchyma (window width 1,000, window level –700 HU) and the other for the pleura and the mediastinum (400, 40 HU). Figure 1 shows a CT slice to be analysed. In addition, 4–7 high-resolution (HRCT) slices (200 mA, 130 kV, 1.5-mm slices, window width 1,000, window level –700 HU) were exposed from the aortic arch or pulmonary hila to the lung bases (standardised system).

The controls were imaged with a Siemens Somatom Plus or Somatom 4 Plus scanner (contrast-enhanced spiral examination according to the clinical indication, 10-mm-thick slices and four extra HRCT slices due to this protocol, 1 mm thick).

**Statistical methods**

The average inter-observer agreement for all three observers considering all nine of the above-mentioned variables was computed using quadratic weighted kappa (kqw), which is equal to the intraclass correlation. Pooled intra-observer agreement of all three observers was calculated between the two reading sessions for the same variables.