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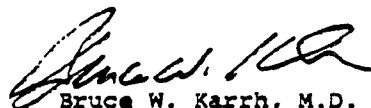
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COMPANY PHYSICIANS

ASBESTOS-RELATED CHANGES

The attached article by Sargent provides
pertinent information regarding pleural plaques and
the association with asbestos exposure and may be
helpful to you.


Bruce W. Karrh, M.D.
Corporate Medical Director

BWK:ceb

Attachment

DUP 0937360

There's a world of things we're doing something about

DU 038331

Pleural Plaques: A Signpost of Asbestos Dust Inhalation

E. Nicholas Sargent, M.D., George Jacobson, M.D., and Jay S. Gordonson, M.D.

The general contamination of the urban atmosphere by asbestos dust has become a matter of public concern. Industrial exposure of workers to this dust is also widespread. The radiologist and other physicians should be familiar with the occupations in which asbestos dust exposure occurs and should be aware that asbestos is used in more than 3000 commercial items. The major cause for failure of public health agencies to control asbestosis is the long latent period (often 20 years or more) between the beginning of work exposure and the appearance of overt disease. The disease now being discovered was initiated by industrial exposure during or before World War II. Before the 1950s, few precautions were taken to protect workers from this noxious dust. Thus it follows that to prevent asbestos dust disease in the year 2000 we must recognize its characteristic radiographic appearance now and take appropriate measures to reduce exposure wherever evidence of the disease is found.

Although asbestos dust inhalation is not the sole cause of pleural plaques, it is certainly the most common. The association between pleural plaques and occupational or nonoccupational asbestos dust exposure has been amply confirmed by population studies.¹ The prevalence of pleural changes seen on radiographs has been shown to increase in relation to the estimated dose of asbestos, the age of the patient, and the length of time after initial exposure to asbestos.^{2,12,22,24} This is further confirmed by a fairly strong correlation between pleural plaques found on postmortem studies¹⁴ and a history of previous exposure to commercial types of asbestos.^{12,24} All varieties of asbestos

have been implicated, but the highest rate of association occurs with anthophyllite.⁴

In addition, other factors such as the site and nature of the geologic deposit of the asbestos may be important. For example, in the chrysotile mining areas of Quebec, the occurrence of pleural plaques in miners is common in some mines, rare in others, and absent in one of the largest mines not too distant from the others.¹⁸ In nonoccupationally exposed populations, particularly in Finland, the prevalence of pleural plaques relates to the proximity of residence to certain mining areas, and the air is so polluted that even cattle are contaminated.^{4,14,16} Similarly, plaques have been observed in some agricultural populations¹⁴ and in cattle¹⁹ in areas in which the soil is contaminated with asbestiform materials.

PATHOGENESIS AND PATHOLOGY

To date, no totally satisfactory explanation has been developed to explain how the pleural reaction that results in plaques develops in response to the inhalation of asbestos fibers and particles. Asbestos bodies have rarely been found in plaques,¹⁵ but asbestos fibers may be present. However, the lack of asbestos fibers in plaques mentioned by previous investigators has largely been due to inadequate techniques.²⁵ By means of recently developed techniques of transmission electron microscopy, selective area electron diffraction, and microchemical analysis of particles, many small submicroscopic asbestos fibers in pleural plaques have been identified unequivocally by morphologic, structural, and chemical studies.^{16,22} It is of interest that these are more concentrated in the calcified zones than in the fibrous zones.¹² Asbestos fibers are also commonly observed in the lung tissues of patients with plaques.^{7,12}

Inhaled fibers longer than those that can be phagocytosed by histiocytes or giant cells move downward and outward in the lungs. This type of gravitational movement (so unusual in other pneumoconioses) is influenced by the coincidence of three variables: the presence of thin, sharp asbestos fibers; the soft, easily punctured pulmonary structure; and the constant motion of the lung.²⁶

E. Nicholas Sargent, M.D.: Professor of Radiology, LAC-USC Medical Center, Los Angeles, Calif. George Jacobson, M.D.: Professor of Radiology, LAC-USC Medical Center, Los Angeles, Calif. Jay S. Gordonson, M.D.: Assistant Professor of Radiology, LAC-USC Medical Center, Los Angeles, Calif.

Reprint requests should be addressed to E. Nicholas Sargent, M.D., Box 677, Department of Radiology, LAC-USC Medical Center, 1200 N. State Street, Los Angeles, Calif. 90033.

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DUP 0937361

287



Fig. 2. Advanced stage of well-developed bilateral pleural plaque formation crossing intercostal spaces. Note the sharp margin (arrows) adjacent to the ribs, where the plaques are seen in profile, even through the overlying scapula. Tapering of the margins superiorly and inferiorly is evident, particularly on the right. Localized well-developed plaques alter the contour of the left hemidiaphragm and to a lesser extent the right (white arrow heads).

Noncalcified Pleural Plaques

Noncalcified hyalinized pleural plaques are not visualized radiographically until the fibrous tissue is sufficiently thick; thus they often go undetected, and their prevalence during life is underestimated. Only a small percentage of early plaques identified at postmortem examination have been detected on routine PA radiographs.⁷ In this projection a well-developed pleural plaque results in either a *profile* presentation or an *en face* presentation. The plaque in profile appears as a sharply marginated white band of water density, roughly

paralleling the inner margin of the lateral thoracic wall. It is usually not obscured by the overlying scapular shadow (Fig. 2).

The very early plaque will show only a thin white line of increased density adjacent to the rib that has been likened to a flange.¹ Thus the profile line of early plaque formation is easily overlooked and often detected only in retrospect (Fig. 3), particularly when it resembles the normal inner rib surface. As it enlarges, it becomes somewhat oval and moderately protuberant, with tapering superior and inferior margins typical of an extrapleural lesion (Fig. 4). A plaque rarely extends vertically more than

DUP 0937362



Fig. 3. Pleural plaques (black arrows), bilateral noncalcified on/oss. (A) PA film. The hazy veil-like densities along the lateral margins of the lung fields spare the apices and costophrenic angles. A few small plaques are seen in profile (white arrows). (B) Right oblique view. The on/oss plaques are projected in profile, posteriorly on the right and anteriorly on the left (arrows). (C) Left oblique view. The converse is noted. The costophrenic angles are spared on all projections.

DUP 0937363

greater or lesser extent, deposition of fat. The sharp medial margin of the shadow is best seen when the x-ray beam is tangential to the surface of the tissues causing this shadow. This normal pleural shadow increases in width as it is traced superiorly toward the first rib; it usually tapers rapidly inferiorly, becoming imperceptible below the level of the 4th intercostal space. In the PA projection the thickness of the shadow is never greater than 5 mm; however, in the oblique projection this normal pleural shadow is wider, varying from 0 to 10 mm in the men and somewhat less in women.²⁰ Occasionally, a very thin, barely perceptible line may be seen medial to the lower half of the lateral thoracic wall; 1 mm has arbitrarily been designated as the maximum acceptable thickness of this normal pleural shadow below the level of the 4th intercostal interspace.

The costal slips of origin of the serratus anterior and external abdominal oblique muscles have a characteristic radiographic pattern: a rhythmic sequence of shadows between successive intercostal spaces (Fig. 6). They are most commonly visible over the 5th rib, but the 7th rib is also affected, and occasionally all of the ribs from the 5th to the 9th are involved. They appear as one or two distinct triangular shadows or a combination of two opacities superimposed. They should not be mistaken for multifocal plaques, which may also show a series of shadows. Multiple plaques are more likely to differ from each other in size and shape, unlike muscle shadows, which are usually more uniform in size. The muscle shadow usually has one sharply defined border and elsewhere fades into the surrounding soft tissues. A slightly oblique projection will often resolve this difficult problem. A plaque that is well defined in profile becomes ill defined when rotated to an *en face* position. Additional plaques are often seen on the rotated film. Plaques may become more distinct as rotation moves the overlying muscle shadows, whereas muscle shadows will alter their shape or disappear.

Pleural thickening should not be confused with extrapleural deposits of fat. The oblique view is again helpful, the fat producing a wavy margin most prominent on the posterolateral surface of the ribs, usually sparing the anterior and paravertebral areas.²¹ Tomography may be



Fig. 6. Normal costal slips of origin of serratus anterior and external abdominal oblique muscles (arrows). These are bilateral symmetric shadows, not to be confused with pleural plaques. The sharp medial margins fade inferiorly. The shadows disappear completely on oblique views.

helpful in revealing fat density in contrast to the water density of pleural thickening.

Calcified Pleural Plaques

Pleural calcification usually occurs 20 years or more following exposure to asbestos. The incidence increases with the time interval.²² The exposure to asbestos does not have to be prolonged; it can be on the order of only a few weeks or months, depending on the concentration of the dust. However, calcification in pleural plaques is a relatively uncommon radiographic finding. It is much more common histologically, occurring in approximately 37% of plaques.²³ Radiographically demonstrable evidence of interstitial pulmonary disease has been reported in only one-third of patients with pleural plaque calcification, but conversely more than 50% of patients with extensive

DUP 0937364



Fig. 2. Calcified pleural plaques. (A) PA film. An /-oss calcifications on right; linear calcifications in profile in mediolateral reflection of pleura on right and in pericardium on left (transverse arrow); linear calcification in vertical profile in left diaphragmatic pleura. (B) Left oblique film. A linear pleural calcification is seen in profile in the area of the anterior tendon of the right hemidiaphragm (arrow). The an /-oss plaques of (A) now appear in profile as extensive linear calcifications (arrow heads) adjacent to anterior ribs.

DUP 0937365

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