The Radiologic Significance of the Left Pulmonary Ligament*

Experience with 26 Patients

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Pathologic processes confined to or by the left pulmonary ligament present a confusing radiographic appearance. Such processes may simulate pleural scarring, parenchymal scarring, or even left lower lobe collapse. Radiologic awareness of this structure is limited because in the normal state, it is not visualized on either posteroanterior or lateral chest x-ray films. The absence of secondary signs of left lower lobe collapse, together with a process which may extend above the level of the left hilum, is valuable in confirming that such a triangular density seen behind the left cardiac border is disease in or confined by the pulmonary ligament, rather than left lower lobe collapse.

The number of reports of pathologic processes involving the left pulmonary ligament (the triangular ligament) are few.\textsuperscript{1-3} When present, such processes are frequently mistaken on chest x-ray films for other abnormal conditions. The pulmonary ligament produces no discernible shadow on either the posteroanterior or left lateral projection on a normal chest x-ray film. The radiographic significance of the left pulmonary ligament was first described by Rabinowitz and Wolfe\textsuperscript{1} in 1966. Few subsequent reports\textsuperscript{2,3} have described pathologic processes of this structure. These reports\textsuperscript{2,3} dealing with posttraumatic pneumatoceles of the left pulmonary ligament, helped to elucidate the confusing radiographic appearance resulting from abnormalities of this structure. We have recently encountered 26 cases in which a triangular or linear density behind the left cardiac border proved to be a pathologic process within or confined by the left pulmonary ligament. The presence of left lower lobe collapse was the initial radiographic impression in several of these cases.

Anatomy

The root of the lung is covered anteriorly and posteriorly by pleura.\textsuperscript{1} At the lower border of the hilum, the investing layers of visceral pleura come into contact with one another. At the point of contact, the pulmonary ligament is formed. The ligament descends (coursing posteriorly) from the root of the lung towards the diaphragm (Fig 1A and 1B). The ligament attaches the medial surface of the lung to the mediastinum, separating the pleural space below the root of the lung into an anterior and posterior compartment. The ligament may continue inferiorly and attach to the diaphragm, thus creating a "bare area" on the surface of the diaphragm, or it may end above the diaphragm in a free falciform border.

The pulmonary ligament serves to stabilize the lower medial portion of the lung. When the lung is displaced laterally away from the mediastinum, the pulmonary ligament is stretched, resulting in the ligament assuming a triangular configuration (hence, the appellation, "triangular ligament"). The superior or lateral margin of the triangle is the attachment of the ligament to the medial margin of the left lower lobe. The mediastinal pleura immediately posterior to the heart forms the medial border. The junction with the diaphragmatic pleura forms the inferior border. The root of the lung is the apex of the triangle. The medial border of the triangular (pulmonary) ligament is adjacent to the esophagus and descending aorta. The two sheets of pleura constituting the ligament enclose a network of connective tissue which blends intimately with the tissues about the hilum of the lung and with the tissues about the esophagus and descending aorta.

Injection of the pulmonary ligament in a cadaver demonstrates the location, shape, and anatomic relationships of this structure (Fig 2). The apex of the ligament is firmly adherent to the left hilum just below the inferior pulmonary vein. The inferior margin or base of the pulmonary ligament in this

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specimen is its junction with the pleura over the diaphragm.

**Radiographic Findings**

Twenty-six patients with pathologic processes in or confined by the left pulmonary ligament have been seen in the past 20 months at Northwestern Memorial Hospital, Chicago. In 14 patients the process simulated left lower lobe collapse. In ten patients a scar extended from the inferior portion of the left hilum in an inferior, lateral, and posterior direction, simulating a parenchymal or pleural process. An unusual air-filled triangular density extending inferiorly and laterally from the left hilum was demonstrated in two patients.

Scarring, probably secondary to old inflammation in the region of the left pulmonary ligament was thought to be responsible for the density in eight of these 26 patients (Fig 3). Fluid located in either the anterior (ten cases) or posterior (five cases) mediastinal pleural space accounted for 15 triangular densities superimposed over the cardiac silhouette (Fig 1C, 1D, 4A, and 5A). A pneumatocele confined to the left pulmonary ligament was also seen in two patients (Fig 6). Chronic infection was responsible for visualization of the left pulmonary ligament in one patient (Fig 7).

Abnormalities in the pulmonary ligament do not depress the hilum, do not elevate or obscure the left hemidiaphragm, and do not create a radiopaque triangular density in the posterior inferior gutter on the lateral view of the chest. These are the secondary signs of the left lower lobe collapse. Their absence,
in the presence of a linear or triangular density behind the heart, suggested the presence of another process, rather than collapse of the left lower lobe, in all of these patients.

Scarring of the left pulmonary ligament has not been reported previously (Fig 3). When present as a simple linear density extending inferiorly and laterally and arching posteriorly from the left hilum, scarring of the left pulmonary ligament can be confused with parenchymal or pleural scarring. Less frequently, such a scar may simulate left lower lobe collapse on a posteroanterior chest x-ray film (Fig 3A).

The pulmonary ligament influences the distribution of fluid in the pleural space. Pleural effusions localized by the pulmonary ligament may simulate lower lobar collapse (Fig 4A and 5A). The absence of secondary signs of collapse is important in establishing the true nature of the triangular density behind the heart (Fig 4 and 5). When fluid is trapped either anteriorly or posteriorly, a triangular density is formed immediately lateral to the spine and behind the heart (Fig 5). Anterior accumulations are usually associated with fluid elsewhere in the pleural space (Fig 4). The presence of pleural effusion elsewhere is therefore helpful in establishing the cause of the triangular density in the absence of other signs of left lower lobe collapse. Decubitus films of the chest can be obtained to confirm this radiographic impression.

With the patient erect, fluid localized to the posterior mediastinal compartment also produces a triangular density behind the cardiac silhouette, with the apex at or above the inferior portion of the hilum (Fig 5A). In the lateral projection, this localized collection of fluid is frequently difficult to recognize (Fig 5B). Decubitus films can confirm the presence of free fluid.

Pneumatoceles (Fig 6) of the left pulmonary liga-

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**Figure 2.** Injection of left pulmonary ligament in cadaver shows extent of ligament. Apex of ligament is firmly adherent to left hilum just below inferior pulmonary vein. Base of ligament in this specimen terminates at pleura over dome of diaphragm.

**Figure 3.** Triangular density (arrows) behind left cardiac border in 64-year-old asymptomatic white woman. A (left), Triangular density simulates left lower lobe collapse. Unlike such collapse, density extends above level of hilum, and there are no primary or secondary signs of such collapse. An overpenetrated view showed that triangular density behind left cardiac border was area of scarring extending from medial portion of left hemidiaphragm superiorly and medially to mediastinum above hilum. B (right), Frontal view of chest taken two years earlier shows origin of linear density (arrows) in left lower pulmonary field. Left pulmonary ligament (arrows) extends from region of inferior pulmonary vein to diaphragm. Further extension of this “scar” superiorly and medially was thought to be responsible for triangular density simulating left lower lobe collapse.
FIGURE 4. Frontal (A, left) and lateral (B, right) chest x-ray films of 33-year-old white man with Hodgkin's disease of stage 4B, showing triangular density (arrows) behind left cardiac border and subpulmonic effusion. Fluid is also seen in subpulmonic distribution anterior to ligament on lateral x-ray film. In left lateral decubitus view, triangular density seen on posterolateral view disappeared, and free-flowing effusion was shown laterally.

FIGURE 5. A (left), Supine chest x-ray film of white man three hours after motor vehicle accident. Large homogeneous triangular density (arrows) is seen behind left cardiac border. B (right). Lateral tomogram 14.5 cm from top of table with right side dependent confirms presence of effusion trapped anteriorly by left pulmonary ligament, which is responsible for triangular density seen on frontal x-ray film.

ment may simulate all sorts of abnormal collections of air in the left lower lobe. The peculiar triangular density extending from the hilum inferiorly towards the diaphragm should suggest the presence of air confined to the leaves of the pulmonary ligament.

Chronic infections can involve the pulmonary ligament, creating a triangular density which simulates left lower lobe collapse (Fig 7). The absence of any of the signs of collapse, other than the triangular density, is extremely helpful in establishing the anatomic location of the pathologic process.

Since the pulmonary ligament is composed of two sheets of pleura enclosing a network of connective tissue blending with the hilum, esophagus, and
aorta, infections or air originating in the ligament may extend above the hilum by direct spread into the tissues surrounding the aorta and esophagus. Spread into the connective tissues results in a triangular density which extends above the hilum (Fig 3A).

DISCUSSION

In its normal state the triangular ligament is not demonstrated radiographically. In pathologic states the left pulmonary ligament may be seen as a triangular density simulating left lower lobe collapse or as a peculiar linear density simulating a pleural or parenchymal process behind the heart. Unlike lower lobe collapse, pathologic processes of the triangular ligament fail to produce a triangular density in the posterior and inferior portion of the lung on the lateral x-ray film. Both hemidiaphragms are well defined, and the secondary signs of left lower lobe collapse (displaced fissures, elevation of the hemidiaphragm, or depression of the hilum) are not present. Frequently, left lower lobe collapse is present without all of the primary or secondary signs. In those instances, it is important to identify the homogeneous triangular density in the posterior and inferior portion of the chest on the lateral x-ray film. If this triangular density is absent, if the left hemidiaphragm is well defined posteriorly, and if the density is seen through the heart on the postero-anterior views, disease confined to or by the pulmonary ligament should be strongly suspected.

Collapse of the left lower lobe creates a triangular density which usually terminates in the middle portion of the hilum. The left triangular ligament blends with the tissues about the hilum of the lung and mediastinal structures. When the triangular density extends above the level of the left hilum, left lower lobe collapse is unlikely. This is valuable in placing the pathologic processes in the left pulmonary ligament, with extension into the mediastinal structures.

Because of the proximity of the heart and its contact with the left pulmonary ligament, fluid tends to accumulate anterior to the pulmonary ligament on the left side of the chest with much greater frequency than on the right. The fluid becomes trapped behind the heart anterior to the ligament. Since fluid in the anterior pleural space accounts for 10 of 26 visualizations of the left pulmonary ligament, clearly the presence of the heart and its position relative to the ligament is responsible for the greater number of visualizations of the left pulmonary ligament, as compared to the right pulmonary ligament.

The paucity of reports of pathologic processes related to the left pulmonary ligament is most likely related to the confusing radiographic appearance of such processes and the radiologist’s lack of familiarity with this normal structure. We believe that pathologic processes associated with the left pulmonary ligament are far more frequent than indicated by the relatively few reports in the literature. We think that such processes will be found if more physicians are aware of their appearance and potential presence.

REFERENCES