Early Detection of Pleural Fluid*

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Displacement of a sharp "costophrenic angle," rather than blunting of the "costophrenic angle," is emphasized as one of the earliest signs of pleural fluid. Examples of this sign are illustrated, and its pathophysiology is discussed.

In recent years, several articles have appeared pertaining to the roentgenographic diagnosis of pleural fluid.1,2 In the posteroanterior projection, much emphasis has been placed on the concave meniscus which appears in the lateral costophrenic sulcus (blunting). Subpulmonic fluid can be diagnosed by apparent elevation of one hemidiaphragm.

Other signs seen in the posteroanterior projection include lateral displacement of the apparent diaphragmatic peak, a sign which may be exaggerated on expiratory views.3 Occasionally, a clue may be absence of the normally seen lower lobe vessels as they course posteriorly below the anterior hump of the diaphragm.4 On the left, excessive separation of gastric air from pulmonic air may alert one to the presence of pleural fluid.

In the lateral view, blunting may be observed posteriorly, which is usually held to be the earliest sign of pleural fluid, since the posterior costophrenic sulcus is the most dependent portion of the pleural space in the upright patient. Subpulmonic fluid may be diagnosed by straightening of the anterior edge of the apparent hemidiaphragm. Fluid dissecting into the major fissure (or into an inferior accessory fissure in a posteroanterior projection) is also a finding.

Seemingly lost in recent discussions is a sign first described by Fleishner4 in 1927 and reemphasized by Hessen4 in 1951. Originally called lamellar pleurisy, "displacement of the costophrenic angle" is a more descriptive phrase. That is to say, the angle is not blunted; it retains its normal sharp angulation but is displaced from its location along the lateral wall of the chest.

ANATOMIC FINDINGS

Anatomy

In a normal patient the visceral and parietal pleural surfaces are apposed to one another. When in certain diseases, pleural fluid accumulates within this "potential space," the retractile force of the lung will cause these pleural surfaces to separate.

Radiographically, the parietal surface cannot be seen on a posteroanterior chest x-ray film. The parietal pleura is too thin to absorb sufficient radiation to cast an image on the film; however, it can be located precisely on a posteroanterior chest x-ray film. Examination of the inside of a hemithorax (in a cadaver or at surgery or by computerized tomographic scanning) demonstrates that the parietal pleura is adherent to the inner surface of the ribs. Even in obese persons the fat may protrude between the ribs but usually does not insert itself between the rib and the parietal pleura. Therefore, if a dot is placed on the inner curve of each rib on a posteroanterior chest x-ray film, then connecting these dots creates a line that exactly corresponds to the parietal pleural surface (seen in tangent as it goes from the anterior portion of the thorax to the posterior portion of the thorax).

Likewise, the visceral pleural surface cannot be seen on a posteroanterior chest x-ray film. In the normal patient, this surface is too thin to cast a density on the
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Figure 1. X-ray film shows normal relationships. Visceral and parietal pleural surfaces touch (solid horizontal arrows). Costophrenic angle is in its normal position adjacent to rib (hollow vertical arrows) (case 1).

film. The surface can be precisely located because it is situated where the lung ends. If a series of dots is placed at the most lateral extent of the lung, then a line is created corresponding to the visceral pleural surface.

In the normal person, these two lines exactly superimpose (that is, in the normal person the lung extends to the inner curve of the rib, from the costophrenic angle almost to the apex) (Fig 1). In a person with pleural fluid, these pleural surfaces are separated by a density due to fluid (most clearly seen in the lateral costophrenic sulcus in the erect person). This is true regardless whether the angle is blunted or sharp (Fig 2).

Physiologic Findings

Physiology

What is the "normal" pattern of accumulation of fluid in the pleural space (in the erect person without preexisting disease)? This pattern is the result of the following three main forces: (1) gravity, which tends to keep the fluid in the dependent portion of the hemithorax; (2) the structural rigidity (form compliance) of the lung, which tends to retain its "pulmonary" shape; and (3) the ability of the lower lobes to change volume independent of the other lobes, which is variously ascribed to greater retractility because of greater distance from the hilus (longer elastic fibers?) or to "pre-atelectasis" secondary to accumulation of secretions in small bronchioles in a lung whose excursion is impaired because of the presence of pleural fluid.

In its earliest stages, fluid will accumulate in the posterior costophrenic sulcus, the most dependent portion of the hemithorax. At this stage, pleural fluid can be diagnosed on the lateral view; however, it may be difficult because of the superimposition of each hemidiaphragm and because of the overlying dorsal spine, particularly the pedicles, which have a concave direction that can simulate a meniscus.

Nearly simultaneous with this, pleural fluid will appear in the lateral costophrenic sulcus and can be seen as medial displacement of the costophrenic angle (really the lower edge of the lung) but without blunting (Fig 3 and 4). It remains sharp because the edge of the lung still has enough structural rigidity to maintain its edge, thereby forcing some of the fluid to go to the

Figure 2. Right and left costophrenic angles demonstrate separation of visceral and parietal pleural surface (solid horizontal arrows). Each costophrenic angle is sharp, although it is displaced from inner curve of rib (hollow vertical arrows). This patient had chronic renal disease and frequently had small pleural effusions (case 1).

Figure 3. X-ray film shows normal left costophrenic angle (arrow). Note relationship of left hemidiaphragm with ninth rib (9) (case 2).
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Figure 4. X-ray film taken during episode of congestive heart failure shows separation of visceral and parietal pleura (solid horizontal arrow). Costophrenic angle is sharp but displaced from inner curve of rib (hollow vertical arrow). Note relationship of hemidiaphragm with ninth rib (9) has not changed (case 2).

side of the lung. (Imagine immersing a lung in a bucket of water. As the lung enters the water, the force of the water somewhat flattens the lower margin of the lung; however, the structural force of the lung itself also affects the water, indenting it, with fluid going around the side to a point above the lowest edge of the lung.)

As more fluid accumulates, the alveoli in the edge of the lung (subject to the pressure of fluid on both sides) may collapse, thereby making the sharp edge of the lung become round and producing the familiar meniscus or blunted costophrenic angle (Fig 5).

Displacement of a sharp "costophrenic sulcus" is seen in most cases of subpulmonic fluid. Its presence is useful in distinguishing between subpulmonic effusion and diminished diaphragmatic excursion. Its presence is a sensitive indicator of the presence of pleural fluid; however, it cannot be used to determine how much fluid is present. It should be used to encourage the obtaining of lateral decubitus views.

CONCLUSION

The pathophysiology of the various roentgenographic

Figure 5. X-ray film taken on Feb 20, 1976, shows blunting of costophrenic angle (arrow). Elevated position of apparent hemidiaphragm in relation to ninth rib (9) may indicate increasing amount of pleural fluid (case 2).

signs of pleural fluid have been discussed. Different signs may be present in different patients; however, in the erect person, detection of separation of the visceral and parietal pleura (separation of a sharp pulmonary angle from the inner curve of the rib) by a density due to fluid seen best in the costophrenic sulcus in the posteroanterior projection remains a constant and easily detectable clue when carefully sought.

REFERENCES

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