Despite the increased use of CT imaging, chest radiography remains a very important diagnostic modality in the evaluation of lung parenchymal and mediastinal diseases, providing a vast amount of useful information. This information is generally derived from the relationships among the normal anatomic structures of the mediastinum, pleura, and lungs, which represent the basis of the “cardiac silhouette” and “mediastinal lines-and-stripes” concepts that potentially play an important role in the establishment of a diagnosis or a spectrum of diagnoses before proceeding to CT imaging. The capability of recognizing an abnormal chest radiograph on the basis of the displacement, deformation, or obscuration of one of these structures when compared with those in normal findings is often mandatory prior to requesting a potentially useful CT scan examination. Therefore, radiologists, trainees, and physicians must be familiar with the anatomic basis of those findings to be able to recognize the normal and abnormal appearance of structures when developing an appropriate differential diagnosis. In this review, we briefly describe the cardiac silhouette concepts and the mediastinal lines-and-stripes configurations as they relate to the radiographic and CT scan appearance of structures for a spectrum of pathologic diseases and list the possible underlying causes of the displacement, deformation, or obscuration of the structures.

Abbreviations

CXR

chest radiograph
Chest radiography remains the first diagnostic step for the evaluation of lung parenchymal and mediastinal diseases, providing a vast amount of useful information. Data are generally derived from the relationships among the normal anatomic structures of the mediastinum, pleura, and lungs, which represent the basis of the “cardiac silhouette” and “mediastinal lines-and-stripes” concepts that potentially play an important role in the establishment of a diagnosis or a spectrum of diagnoses before you can proceed to chest CT imaging. The capability of recognizing an abnormal chest radiograph (CXR) on the basis of the displacement, deformation, or obscuration of one of these structures when compared with those in typical radiographic findings is often mandatory prior to request a potentially useful chest CT examination.

**Cardiac Silhouette**

On a normal posterior-anterior (P-A) CXR, the silhouette of the heart borders, the ascending and descending thoracic aorta, the aortic arch, the lateral profile of the superior vena cava (SVC), the azygos vein arch, and the hemidiaphragms should be clear, being outlined by the adjacent air-contained lung. When a consolidating lung (eg, pneumonia, neoplasms, collapse) or soft-tissue mass (eg, mediastinal mass, pleural effusion) contacts one of these structures, its border becomes invisible or poorly defined, producing the “silhouette sign.” [1] [2] [3] The obscuration (“silhouetting”) of specific contours may be related to abnormalities in a specific lobe or lung region as a result of these mediastinal structures being in contact with a specific portion of the lung (Fig 1). Although a frontal radiograph often leads to the suspicion and site definition of a disease, localization is often most precise when coupled with a lateral film (Fig 2), the acquisition of which should be highly recommended in suspect cases.
Figure 1  Relationship of borders of the cardiac shadow with the adjacent lung portion. The deformation, obscuration, or sparing of these profiles is a useful finding in determining the site of disease using a posterior-anterior (P-A) chest radiograph (CXR). Asc = ascending; LLL = left lower lobe; LUL = left upper lobe; LV = left ventricle; PA = pulmonary artery; RLL = right lower lobe; RML = right middle lobe; RUL = right upper lobe; RV = right ventricle; SVC = superior vena cava.

Figure 2  Cardiac borders and mediastinal structures visualized on a lateral CXR, including the LUL bronchus (thin arrow) the anterior wall of the trachea (thick arrow), the left PA (*), the right PA (#), and the posterior wall of the inferior vena cava (IVC) (arrowhead). LA = left atrium; RVOT = right ventricular outflow tract. See Figure 1 legend for expansion of other abbreviations.

So, if an opacity is present in the left hemithorax overlapping the left border of the cardiac shadow, with the edges of the left ventricle and pulmonary artery (PA) still appreciable, the lesion lies posterior (no silhouetting) (Fig 3). Otherwise, if the right heart border is lost as the result of the presence of an opacity in the right cardiophrenic angle, this finding lies anterior (silhouetting) (Fig 4); anyway, if the right heart border is still present, the opacity in the right cardiophrenic angle may have a lower density, as in case of a prominent right cardiophrenic fat pad. Similarly, if an opacity in the left hemithorax on the P-A CXR obscures the left border of the cardiac shadow (silhouetting), sparing the aortic arch (no silhouetting), the disease is located anterior (Fig 5).
Figure 3  No silhouetting on a P-A CXR. A, The opacity in the left hemithorax spares the left cardiac border (arrows) because of its posterior position. B, This opacity (arrows) is well shown in the lateral CXR. C, The CT image confirms the site (arrows) and the nature (pleural effusion) of the disease. See Figure 1 legend for expansion of the abbreviations.

Figure 4  Silhouetting on a P-A CXR. A, A homogeneous opacity with a well-defined lateral border (arrows) obscures the right-sided heart border (dotted line) and extends inferiorly to the right cardiophrenic angle. B, A coronal multiplanar reconstruction (corMPR) CT scan confirms the site of the lesion and its hydric nature (pericardial cyst). See Figure 1 legend for expansion of other abbreviations.

Figure 5  A, P-A CXR shows the presence of a well-defined and homogeneous opacity in the left hemithorax in contact with the mediastinum. The obscuration of the upper portion of the left cardiac border (silhouetting) (arrows) and the consensual sparing of the aortic arch (no silhouetting) (arrowhead) establish the anterior site of the disease (mediastinal mass). B, The disease site is confirmed on a lateral CXR. C and D, CT scans confirm the radiographic interpretation, clearly showing the anterior disposition of the mediastinal mass (arrows) and the absence of any relationship with the posterior portion of the aortic arch (arrowhead). See Figure 1 legend for expansion of the abbreviations.

**Mediastinal Lines and Stripes**

The mediastinal lines and stripes (Fig 6) are both formed by the presence of air in structures that approximate each other, delineating the respectively thinner and thicker intervening tissue on both sides. [4] The mediastinal lines correspond to the
contours of the middle and superior mediastinum and represent the edges of a dense, pleural-covered structure margined by the air within the lung. These lines are typically thin, with a thickness of 1 mm, and include the anterior and posterior junction lines. The mediastinal stripes are thicker lines (> 1 mm), are formed by air outlining the thicker intervening soft tissue, and include the right and left paratracheal stripes. The interfaces, which represent another component of the lines-and-stripes concept of CXR, are formed by the contact of structures with air and are of a different density. The interfaces include the right and left paraspinal lines; azygos-esophageal recess; paraortic, pararterial, and paracaval lines; aortic-pulmonary stripe; and cardiac borders. The absence of one of the mediastinal lines, stripes, or interfaces on a frontal CXR is sometimes insignificant because it may be caused by technical conditions or anatomic variations and the frequency with which they are visualized on CXR varies. CT imaging more clearly indicates the anatomy and formation mechanism of the mediastinal lines and stripes, which helps in the determination of the anatomic and pathologic reasons for their possible displacement, absence, or obscuration.

Figure 6  Mediastinal lines and stripes appreciable on a P-A CXR, with illustrative drawing. Arrows indicate the region of the aortic-pulmonary window. See Figure 1 legend for expansion of the abbreviations.

Anterior Junction Line

The anterior junction line is formed by the apposition of the visceral and parietal pleura of the antero-medial portion of the anterior segments of the upper lobes with a small amount of intervening anterior mediastinal fat. On P-A CXR, it normally shows an oblique course from the upper right to the lower left, crossing the superior two-thirds of the sternum (Fig 7A). Normally it appears as a thin line (mediastinal line), but sometimes it may become visible as a stripe as the result of an increased amount of intervening mediastinal fat (Fig 7B) or possibly the presence of the thymus in younger patients. The line opens superiorly along the innominate veins and is not typically appreciable above the clavicula, and inferiorly, it ends at the level of the superior portion of the pericardium. The anterior junction line can be seen on 24.5% to 57% of frontal CXRs. The heart, great vessels, sternum, or thoracic spine can obscure the line on a frontal CXR. The line can be also absent if its course is not tangential to the x-ray beam. Being located in the anterior mediastinum, its obliteration or deformation can be result from the presence of anterior mediastinal disease (eg, thyroid masses, lymphadenopathies, neoplasms, thymic masses, or lipomatosis). On the other hand, one-sided lung-volume loss or hyperinflation can also displace the line toward the side of the lower-lung volume. On coronal multiplanar reconstruction CT scan and axial CT images, this line can be appreciated as an oblique and thin dense band between the lungs in the anterior part of the chest (Figs 7C, 7D).

Figure 7  A, Normal oblique course and aspect of the anterior junction line (arrows) on a P-A CXR. B, Widening of the line as the result of the presence of fat tissue (arrows), well appreciable on the corMPR CT scan. C, A corMPR CT scan showing a normal, thin, and dense aspect of the line (arrows). D, An axial CT image showing a normal, thin, and dense aspect of the
The posterior junction line is formed by the apposition of the visceral and parietal pleura of the postero-medial portion of the upper lobes posterior to the esophagus and anterior to the third to the fifth thoracic vertebrae (Figs 8A, 8B). It normally appears as a thin line, typically projecting through the trachea, with a vertical course that superiorly opens along the pleural dome and is, therefore, appreciable above the clavicles, while inferiorly, it ends over the aortic and azygos vein arches (Figs 8C, 8D). Sometimes, it may also appear as a stripe as the result of varying amounts of intervening mediastinal fat. The posterior junction line can be seen on 32% of P-A CXRs. Deformation of this line may be caused by posterior mediastinum disease (eg, esophageal masses, lymphoadenopathies, aortic disease, or neurogenic tumors) or sometimes also by intrathoracic goiter with retrotracheal extension (Fig 9). Lung volume loss or hyperinflation of the surrounding lung can also displace the posterior junction line, in a manner similar to that of the anterior junction line.

Figure 8  A and B, The posterior junction line is formed by the apposition of the postero-medial portion of the upper lobes anterior to the third to fifth thoracic vertebrae and is appreciable as a thin, hyperdense line on axial CT images (arrowhead). C, Normal vertical course and thin aspect of the posterior junction line on a P-A CXR (arrows). D, Normal vertical course and thin aspect of the posterior junction line on corMPR CT scan (arrows). This line, projecting through the trachea, superiorly opens along the pleural dome and is appreciable above the clavicles, while inferiorly it ends above the aortic and azygos vein arches. See [Figure 1] . [Figure 4] legends for expansion of the abbreviations.

Figure 9  A, Deformation and widening of the posterior junction line on a frontal CXR, mainly appreciable on the left border (arrows), medially to the pararterial line (arrowhead). B, corMPR CT scan. C and D, Axial CT images show the intrathoracic extension of the lower portion of the left lobe of the thyroid gland with a disposition into the posterior mediastinum lateral to the esophagus (arrows). See [Figure 1] . [Figure 4] legends for expansion of the abbreviations.
Right Paratracheal Stripe

The right paratracheal stripe is formed by contact between the right upper lobe (RUL) and the right lateral wall of the trachea in the presence of intervening mediastinal fat (Fig 10). This stripe begins superiorly at the level of the clavicles and extends inferiorly to the right tracheo-bronchial angle at the level of the azygos vein arch. It is the most commonly seen as a mediastinal line or stripe with a visualization frequency on frontal CXR of 83% to 97%.\[4\], \[10\], \[11\] An abnormal contour or widening of this stripe can be the result of lipomas, paratracheal lymphadenopathies\[12\] (Fig 11), thyroid or parathyroid neoplasms, and tracheal carcinoma. Pleural effusion or thickening can also cause a widening of the stripe.

Figure 10  The right paratracheal stripe (arrows) is the most commonly seen mediastinal line or stripe on a P-A CXR. A, With a normal thickness of 4 mm, it begins superiorly at the level of the clavicles and extends inferiorly to the right tracheo-bronchial angle at the level of the azygos vein arch. B-D, Being formed by the contact (arrows) of the right lateral trachea wall and the RUL, well appreciable on corMPRs and axial CT image. See Figure 1 legend for expansion of the abbreviations.

Figure 11  A, P-A CXR showing right paratracheal stripe enlargement (arrows) as the result of adenopathies in the presence of RUL neoplasm (#) with omolateral hilar enlargement (*). B-D, This finding was confirmed by CT imaging. See Figure 1 legend for expansion of the abbreviations.

Left Paratracheal Stripe

The left paratracheal stripe is formed by contact between the left upper lobe (LUL) and the left lateral wall of the trachea in the presence of intervening mediastinal fat (Fig 12). It extends superiorly from the aortic arch to join with the reflection from
the left subclavian artery.\[13\] This stripe is seen less frequently than the right paratracheal stripe, being visible on 21% to 31% of P-A CXRs, and may be obscured by contact between the left lung and either the proximal left common carotid artery anteriorly or the left subclavian artery posteriorly. Deformation of the stripe can be to the result of lymphoadenopathies,\[12\] neoplasms, or mediastinal masses. An abnormal contour or widening is commonly seen in cases of large left-sided pleural effusion.

Figure 12  A, The contact (arrows) between the LUL and the left lateral wall of the trachea delineates on frontal CXR of the left paratracheal stripe. B-D, The stripe is well appreciable on corMPR CT scan and axial CT image. This stripe is detected less frequently than the right paratracheal stripe on a P-A CXR because it may be obscured by contact between the left lung and either the proximal left common carotid artery anteriorly or the left subclavian artery posteriorly. See [Figure 1] , [Figure 4] legends for expansion of the abbreviations.

Aortic-Pulmonary Stripe

The aortic-pulmonary stripe represents the interface formed by the pleura of the anterior segment of the LUL coming in contact with and tangentially reflecting over the mediastinal fat antero-lateral to the main pulmonary trunk/left pulmonary artery and the aortic arch (Fig 13).\[4\] , \[14\] Normally, the stripe is straight or slightly convex. Its normal appearance may be altered by anterior mediastinal disease such as thyroid and thymic masses, and prevascular lymphoadenopathies often cause increased convexity laterally.

Figure 13  The aortic-pulmonary stripe (arrows) is formed by the contact between the pleura of the anterior segment of the LUL and the mediastinal fat antero-lateral to the main pulmonary trunk/left PA and aortic arch. It delineates the anterior margin of the aortic pulmonary window and is normally straight or slightly convex. A, Straight aortic-pulmonary stripe. B and C, Slightly convex aortic-pulmonary stripe. See Figure 1 legend for expansion of the abbreviations.

Aortic-Pulmonary Window

This mediastinal space is limited cranially by the inferior wall of the aortic arch, inferiorly by the superior wall of the left PA, anteriorly by the posterior wall of the ascending aorta, and posteriorly by the anterior wall of the descending aorta. The medial border is formed by the left tracheal wall anteriorly and the anterior wall of the left main bronchus posteriorly. The contact between the left lung and the aortic arch form the lateral border, which extends down to contact the left PA, with a slight concave interface (Fig 14).\[4\] , \[15\] A laterally concave contour of the aortic-pulmonary window is normal; similarly, a straight shape can be also normal, but it is abnormal when previous CXRs have shown a normal concave contour. The loss of a normal concave aspect with a convexity is considered abnormal and related to different mediastinal abnormalities or
diseases such as prominent mediastinal fat, lymphonodes, bronchial artery aneurysms, nerve sheath tumors, or bronchopulmonary-foregut malformations (Fig 15). Paralysis of the left vocal cord or diaphragm could suggest a search for disease in the aortic-pulmonary window because of the presence of the left laryngeal recurrent and left phrenic nerves in this space. Disease in structures that form the borders of the aortic-pulmonary window (eg, aortic aneurysms) can also determine an abnormal appearance of the window.

Figure 14  A, The aortic-pulmonary window, seen as an interface (arrow) on a P-A CXR, normally has a left convex border, lying behind the aortic-pulmonary stripe, which virtually represents its anterior-lateral limit. B, It is located below the aortic arch as well appreciable on lateral CXR. C-G, The limits of the window are well appreciable on corMPR CT scan and axial images (arrows). The white circles indicate the area of aortic-pulmonary window seen on lateral CXR and relative sagittal corMPR CT scan. See [Figure 1] , [Figure 4] legends for expansion of the abbreviations.

Figure 15  CXRs show aortic-pulmonary window enlargement as the result of a homogeneous and well-defined opacity (arrows). A, P-A. B, Lateral. CT images show the disposition of the lesion in the aortic-pulmonary window, extended laterally, with focal linear calcification, without contrast enhancement and consistent with benign-lesion-like bronchopulmonary-foregut malformation. C, Precontrast. D-F, Postcontrast. See Figure 1 legend for expansion of the abbreviations.

Right and Left Paraspinous Lines

The right and left paraspinous lines are formed by tangential contact between the right and left lungs and pleura with the posterior mediastinal soft tissues. Despite their name, they are not true lines, but are interfaces between the lungs and the paraspinous fat and soft tissues (Fig 16).
The right paraspinous line is normally straight, running from the eighth to the 12th thoracic vertebral bodies, and can be appreciated on 23% of frontal CXRs. On CT images, this line can be well appreciated 5 mm to the right of the spine, in the site where sympathetic nervous structures are placed. A lateral displacement of the line can be the result of osteophytes or prominent mediastinal fat, but it also can suggest a posterior mediastinal abnormality (eg, mediastinal hematoma, mass, or extramedullary hematopoiesis) (Fig 17). The left paraspinous line extends vertically from the aortic arch to the diaphragm and medially to the lateral wall of the descending thoracic aorta (paraortic line). Sometimes, it can lie lateral to the paraortic line along the lower descending thoracic aorta. It occurs on 31% to 41% of frontal CXRs, more frequently than the right paraspinal line as the result of the presence of the descending thoracic aorta on the left, which enhance the tangential contact of the lung-mediastinum interface. On CT images, the emiazygos vein can be often depicted in this space. Similarly, the abnormal contour of the line to the right can be the result of osteophytes or prominent mediastinal fat, while a displacement can suggest posterior mediastinal abnormalities (eg, mediastinal hematoma, mass, extramedullary hematopoiesis, or esophageal varices).

Azygos-Esophageal Recess

The azygos-esophageal recess is not a typical mediastinal line or stripe, but is an interface caused by the difference in density between the mediastinum and the postero-medial portion of the right lower lobe (RLL). It is a space within the mediastinum, lying lateral or posterior to the intrathoracic esophagus and anterior to the spine. It extends from the level of the azygos vein
In its upper third, the recess is continuous with the subcarinal space and can either be straight or concave relative to the right lung; a right superior convexity may be seen in children and younger adults but is abnormal in the elderly. In its middle third, the recess is usually straight, but it can be slightly convex relative to the right lung near the right pulmonary veins and can show mild leftward convexity, and the lower third is usually straight (Fig 18). An abnormal contour or convexity may be the result of different conditions affecting the middle and posterior mediastinal compartments, such as lymphonodes, hiatal hernia or gastroesophageal varices (Fig 19), bronchopulmonary-foregut malformations, esophageal neoplasms, pleural abnormalities, and left atrial enlargement. [16]  [17]

**Figure 18**  A and B, The azygos-esophageal recess (arrows) is an interface determined by the difference in densities between the mediastinum and the postero-medial portion of the RLL. C and D, In its upper third, the recess (arrows) is normally straight or concave relative to the right lung, in the middle portion it is usually straight or slightly convex relative to the right lung, and it is usually straight in the lower portion as well shown on corMPR CT scans. See [Figure 1], [Figure 4] legends for expansion of the abbreviations.

**Figure 19**  A, Enlargement of the inferior third of the azygos-esophageal recess on a P-A CXR with a lobulated and homogeneous opacity (arrows) that is leftward extended. B-D, This finding is consistent with findings on CT images, which show multiple and enlarged venous vessels in gastroesophageal varices. * = enlargement of the lower portion of the left paraspinous line. See Figure 1 legend for expansion of the abbreviations.

**Pararterial Line**

The pararterial line is visible on P-A CXRs above the aortic arch, with a left-oriented course toward the left lung apex, and is produced by the contact of the lateral margin of the left subclavian artery with the LUL edge (Fig 20). Usually this line shows a left-concave shape. [4] Lymphadenopathies, mediastinal or thoracic inlet masses, lung neoplasms or consolidation, pleural
disease, and arterial aneurysm can determine the deformation or suppression of this line.

Figure 20  A, The pararterial line is appreciable on a P-A CXR above the aortic arch, with a slightly left-oriented concave shape (arrows) and is formed by the contact of the lateral wall of the left subclavian artery with the LUL. B and C, The contact is well shown by corMPR CT scans. D and E, The contact is well shown on axial CT images. See [Figure 1] , [Figure 4] legends for expansion of the abbreviations.

Paraortic Line

The paraortic line is appreciable on P-A CXRs behind the cardiac shadow, with a straight and vertical course, external to the left paraspinal line (Fig 21). It is composed by the contact of the lateral wall of the descending thoracic aorta with the left lower lobe (LLL). Usually, in its lower third, the line comes nearer to the vertebral bodies at the level of the 11th thoracic vertebra, overlapping the left paraspinal line. [4] , [10] In the elderly, with the occurrence of atherosclerotic changes of the aorta, it is normal to detect this line displaced away from the vertebrae. An abnormal contour may be the result of different conditions affecting the aortic wall (eg, ectasia or aneurysm) or affecting the LLL and the middle and posterior mediastinal compartments (eg, lung neoplasms, lymphonodes, hiatal hernias, gastroesophageal varices, and pleural abnormalities).

Figure 21  A and B, The paraortic line (arrows) is visible on a P-A CXR, behind the cardiac shadow, with a normal vertical course, external to the left paraspinal line. It is formed by the contact of the lateral wall of the descending thoracic aorta with the LLL. C, A corMPR CT scan. D, An axial CT image. See [Figure 1] , [Figure 4] legends for expansion of the abbreviations.

Paracaval Line

In young patients, the paracaval line represents the right superior limit of the cardiac shadow on a P-A CXR (the so-called first right cardiac arch), formed by the contact of the RUL with the lateral margin of the SVC (Fig 1). In elderly patients, it is more frequently composed by the lateral margin of the ascending thoracic aorta because of its enlargement caused by atherosclerosis or hypertension. [4] This line is characterized by a straight vertical course, terminating in the right atrium. Enlargement of this line could occur in cases of edema, fluid overload, aortic ectasia, or aneurysm, while its deformation or suppression could be the result of mediastinic masses, adenopathies, or lung or pleural neoplasms.

Conclusions

Despite the increased dependence on CT imaging in the evaluation of chest disease, traditional chest radiography still
remains a valuable tool in the routine setting. Radiologists, trainees, and physicians must be familiar with the anatomic basis of the cardiac silhouette and mediastinal lines-and-stripes concepts seen on CXR to recognize normal and abnormal appearances and to develop a suitable differential diagnosis prior to getting additional information using chest CT imaging.

Acknowledgments

Financial/nonfinancial disclosures: The authors have reported to CHEST that no potential conflicts of interest exist with any companies/organizations whose products or services may be discussed in this article.

REFERENCES:

1 Felson B: More chest roentgen signs and how to teach them. Annual oration in memory of L. Henry Garland, M.D., 1903-1966. Radiology 90. (3): 429-441.1968; Citation