RADIOLOGY OF THE HEART

By

DR. SULTAN AHMED SHAH

Inspite of the universal availability of radiological facilities this simple investigation has been rather underutilised in assessment of cardiac diseases.

Advanced haemodynamic studies, no doubt may be essential for more precise information as a pre-requisite to surgical correction, but a correct diagnosis can be inferred in most of the cases by plain chest X-Ray in P.A. and left lateral view. Additional views may be taken for further confirmation of diagnosis if and when necessary.

The Technique: of the chest X-Ray does not differ from that employed in evaluation of pulmonary diseases. Both views should be taken at a distance of 6 feet during the middle phase of respiration and if desirable thick barium may be swallowed to outline the oesaphagus for various measurement.

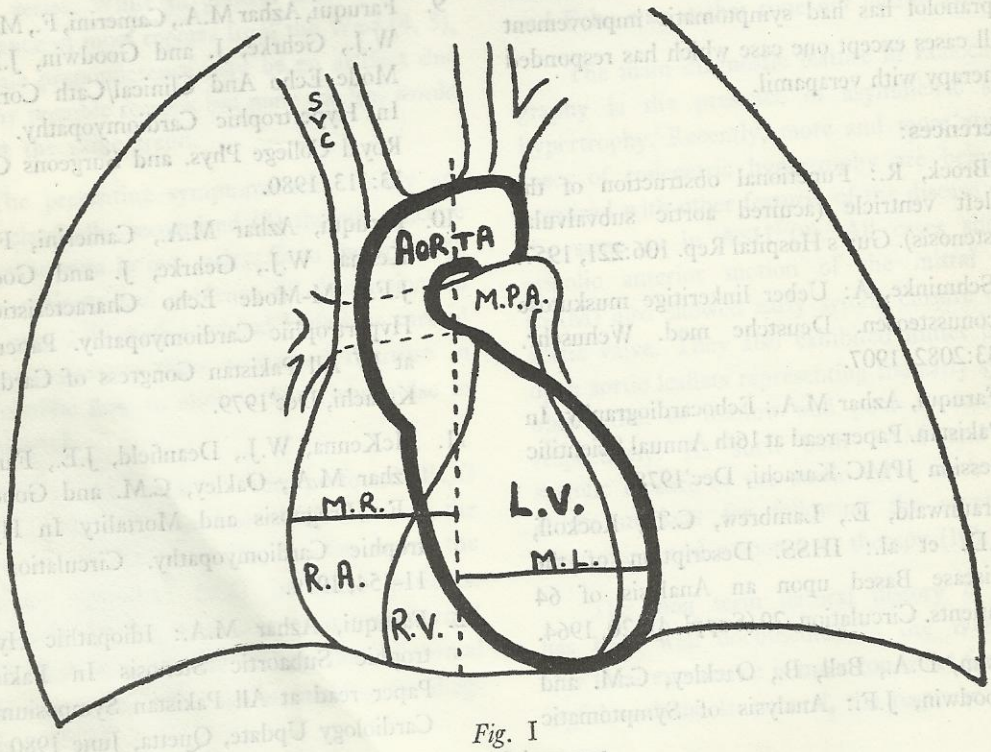

Fig. I

Fig. I illustrates the radiological anatomy of heart in P.A. view. The right border is formed mainly by the right atrium with superior vena cava contributing to the upper portion and inferior vena cava forming the lower most part only during deep inspiration. The left border consists of three well defined segments formed from above down by the end-on appearance of Aorta, left pulmonary artery and left ventricle respectively.

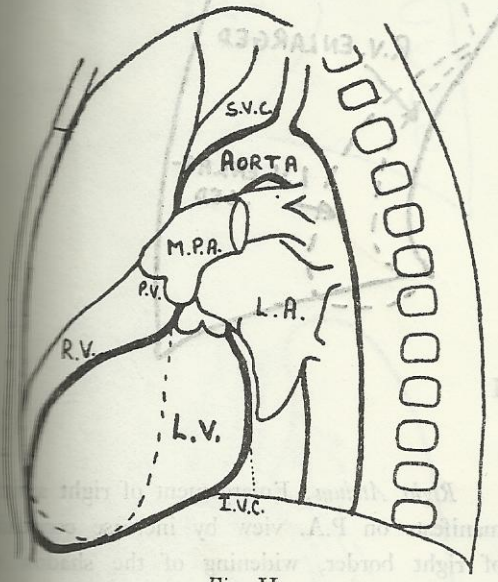

Fig. II

In the left lateral view (fig. II) the following structures outline the Cardiac shadow:-

I. Anterior upper border from above down:
Superior Vena Cava
Ascending Aorta
Pulmonary Trunk

II. Anterior lower border:
Right Ventricle

III. Posterior upper border:
Left Atrium
Pulmonary Veins

4. Posterior lower border:
Left Ventricle
Inferior Vena Cava

The enlargement of the heart is measured by increase in the ratio of transverse cardiac diameter (T.D.) to trans-thoracic diameter which is normally under 1/2. Transverse diameter is the sum of maximum projection on the right and left border from mid line (Fig. I).

The enlargement of individual chambers may be recognized by the following changes:

Left Ventricle: In P.A. view there is elongation of the left border and depression of left diaphragm (Fig. III). In left lateral view the enlarged left ventricle extends beyond in the retrocardiac space which is more obvious in left anterior oblique view where it encroaches on the spine as well (Fig. IV).

Right Ventricle: In P.A. view the left ventricle is tilted up and another controur of right ventricle appears in between the left ventricle and diaphram, occasionally the right border of heart may bulge out due to displacement or right atrium (Fig. III). In left lateral view the right ventricle bulges anteriorly and climbs upwards so that the lower half or more of the sternum is in direct contract with right ventricle instead of the lower one third (Fig. V) in normals.

Left Atrium: This can enlarge more than any other cardiac chamber due to its thin walls, anatomic position, lack of valves between it and the pulmonary vein and the fact that both ventricles pump blood into it in mitral insufficiency (Sloan 1954). It enlarges first posteriorly which is best seen in R.A.O. position (Fig. VI), then to right——left——superiorly (Fig. VII).

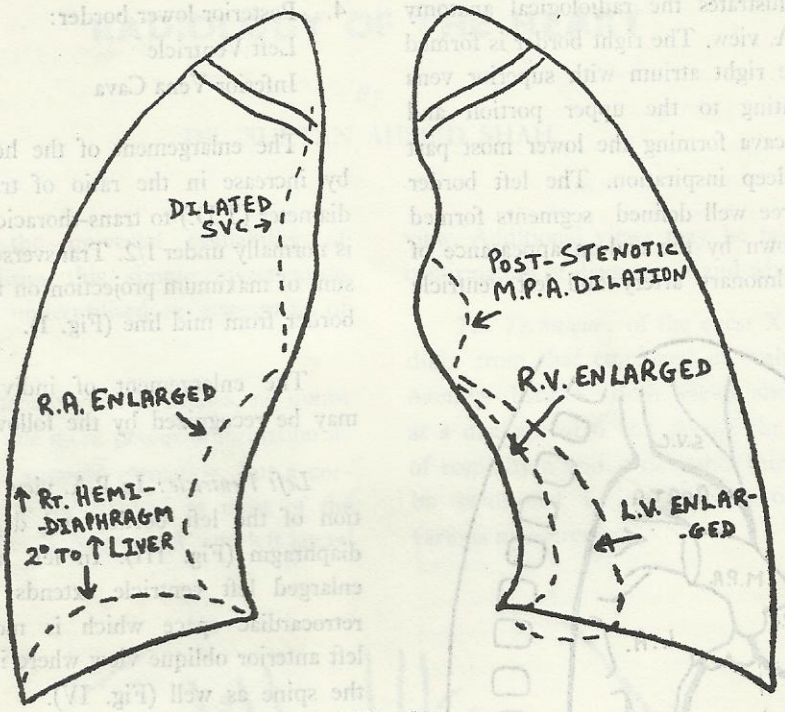

Fig. III

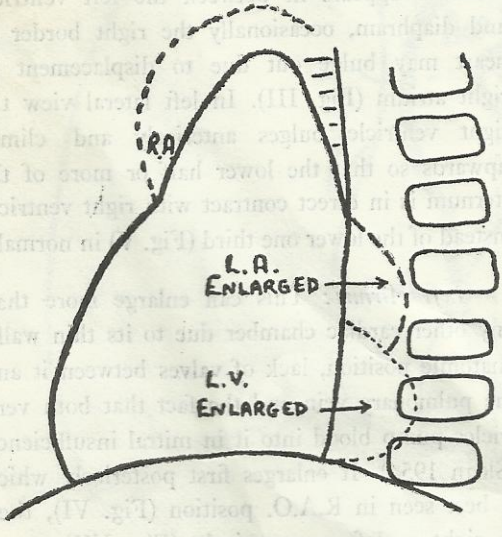

Fig. IV

Right Atrium: Enlargement of right atrium manifests on P.A. view by increase convexity of right border, widening of the shadow of superior vena cava and elevation of right hemi-diaphragm due to hepatomegaly (Fig. III). In the left anterior oblique view (Fig. IV) the enlarged right atrial appendage area imparts a square shaped appearance to the anterior border. In right anterior oblique view (Fig. VII) the main body of right atrium projects behind the oesophagus.

After ascertaining the chamber of heart predominently enlarged, the final diagnosis is made in conjunction with other available evidences.

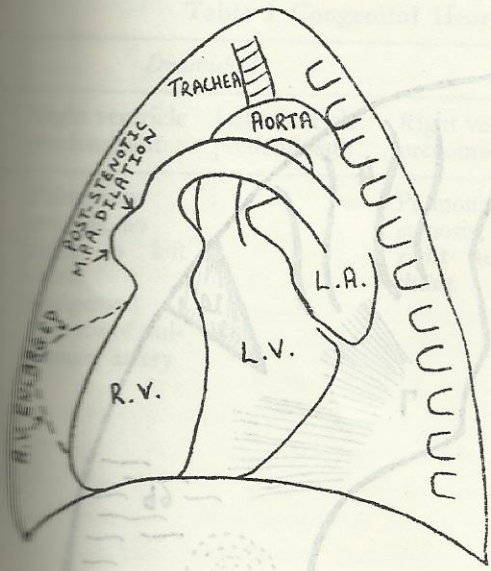

Fig. V

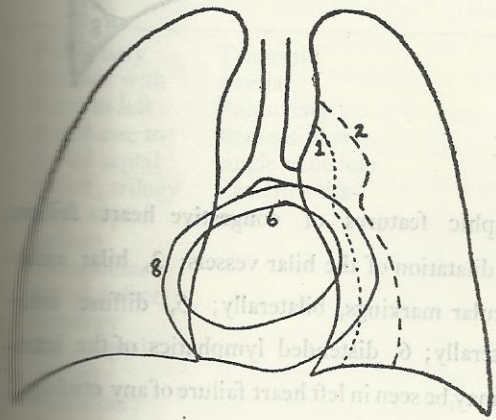

Fig. VI

Thus, in aortic valvular disease apart from left ventricular enlargement there may be calcification of valve and dilatation of aorta. In mitral disease there will be left atrial enlargement with additional changes in the lung and right ventricle in stenosis, and left ventricular enlargement in incompetence.

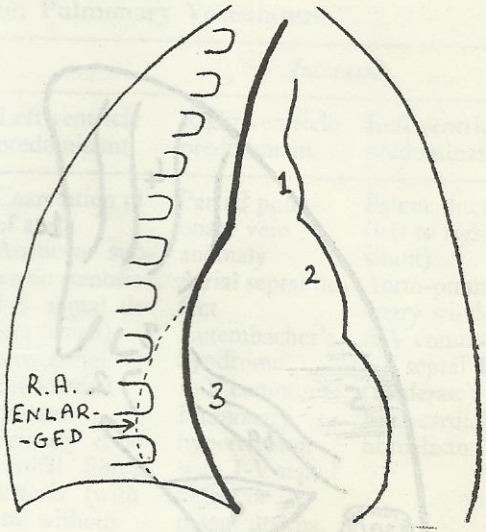

Fig. VII

Pulmonary Vascular Patterns:

Pulmonary Venous Patterns: These reflect the functional aspect of left side of the heart for which it has great diagnostic implication.

The veins can be distinguished from the arteries in the upper lobe by their more lateral location though they cross at hilum to acquire its upper portion. In lower lobe the veins are more horizontal and join perpendicularly the pericardium. The venous pressure is normally under 10 mmHg but may rise with rise in left ventricular end-diastolic pressure or secondary to obstruction in pulmonary veins, left atrial inflow or out-flow tract. If the pressure is raised to less than 20 mm then there is reflex narrowing of lower zone vessels and dilatation of upper lobe vessels. With further rise of pressure upto 30 mm the lower lobe vessels assume normal caliber but the upper lobe vessels remain dilated. Interstitial oedema and small pleural effusion may also appear then. In situations associated with

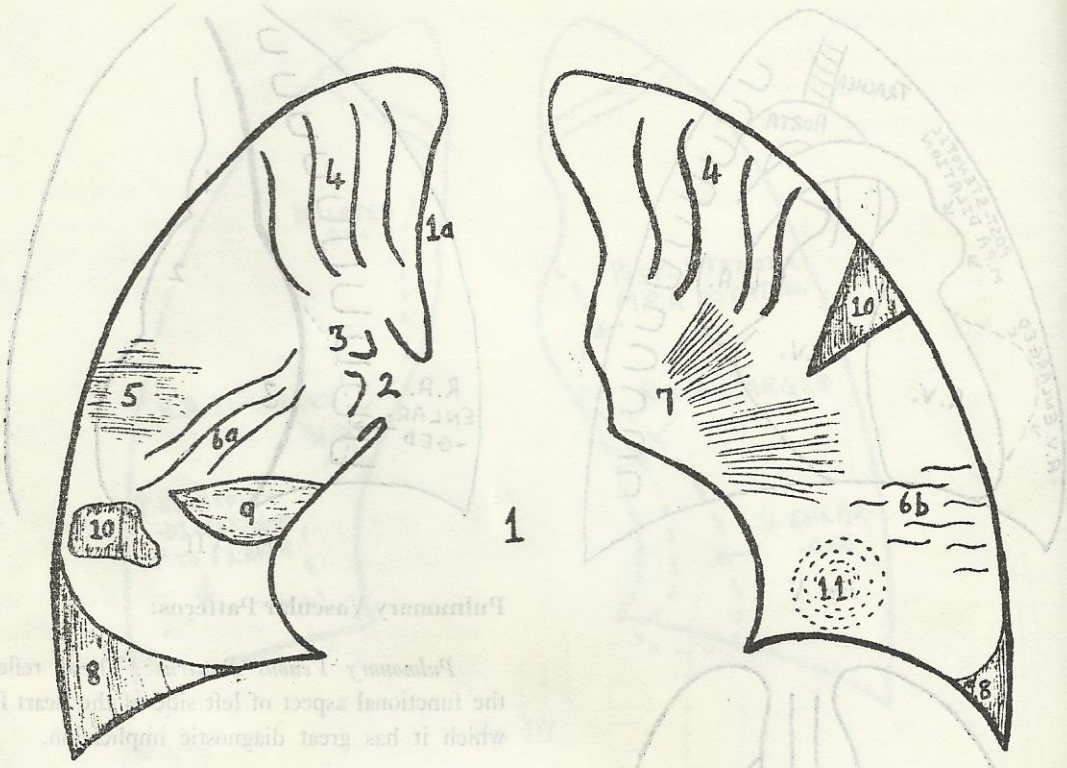

Fig. VIII

Schematic drawing of the cardinal roentgenographic features of congestive heart failure, 1. cardiomegaly, la, dilatation of superior vena cava; 2, dilatation of the hilar vessels; 3, hilar enlargement; 4, increased prominence of the pulmonary vascular markings, bilaterally; 5, diffuse coludiness or "ground-glass" appearance of lung fields bilaterally; 6, distended lymphatics of the interlobular septa; 6a, Kerley's "A" lines (infrequent, but may be seen in left heart failure of any etiology); 6b, Kerley's "B" lines (more common than "A" lines but are seen predominently in cases of mitral stenosis); 7, "fluffy" large confluent transudates of acute pulmonary edema; 8, pleural effusions, usually more marked on the right then the left side; 9, interlobar effusion into oblique fissure; 10, pulmonary infarcts (typical wedge-shaped on left; irregular on the right side); 11, miliary granulomatous mottling throughout the lung fields, more marked in the middle or lower portions due to intra-alveolar exudates.

Table I Congenital Heart Disease: Pulmonary Vasculature

Diminished		*Normal*		*Increased*	
Right ventricle predominant	Left ventricle predominant	Right ventricle predominant	Left ventricle predominant	Right ventricle predominant	Left ventricle predominant
Pulmonary stenosis, no right to left shunt Congenital absence of pulmonary artery		Pulmonary stenosis, no right to left shunt	Coarctation of of aorta Aortic or subaortic stenosis I-V septal defect (small) myocardial or endocardial disease. Primary endocardial fibroelastosis (with and without associated valve defects)	Partial pulmonary vein anomaly Atrial septal defect Lutembacher's Syndrome A-V communis Pulmonary hypertension with I-V septal defect or patent ductus, (Eisenmenger complex) Patent ductus (right to left shunt)	Patent ductus (left to right shunt) Aorto-pulmonary window A-V communis I-V septal defect (moderate) Endocardial fibroelastosis
Pulmonary stenosis with right to left shunt due to: Atrial septal defect; trilogy (I.A. septal defect) Ventricular septal defect; tetralogy (I.V. septal defect) Pulmonary stenosis plus transposition Pulmonary stenosis plus single ventricle Peripheral pulmonary vessel obstructions.	Tricuspid atresia Pulmonary stenosis plus single ventricle Ebstein's disease			Total pulmonary vein anomaly Transposition (no pulmonary stenosis) Taussig-Bing syndrome Single ventricle (no pulmonary stenosis) Truncus arteriosus Aortic atresia Pulmonary vascular obstruction secondary to A-V communis, I-V septal defect, Patent ductus	Truncus arteriosus Single ventricle

Inversions of Cardiac Image or Chambers: Situs inversus and dextrocardia Corrected transposition.

abrupt rise of pressure beyond 30 mm, alveoler oedema characterized by confluent lung shadow and large pleural effusion may be seen. When the rise in pressure is more incepient, perivascular shadows become hazy giving a ground glass appearance. Septal lines (Kerley's) can also be seen then due to collection of fluid in interalveolar septae. The Kerleys B lines are 4 mm wide and perpendicular to pleura, 'A' lines run towards the hilum about 4 cm in length. The Kerleys 'C' lines are much finer and shorter can go in any direction. Fig. VIII illustrates the above radiological signs as well as the other radiological featues associated with congestive cardiac failure.

Initially, the cardiac contour is well maintained so that the predominently affected cardiac chamber can be identified. Dilatation of hilar vessels leads to their further extension in the lung field. Hilum may appear enlarged due to perivascular oedema which may make the identification of the arteries and vein in the hilum difficult. The haziness of the lung field may be due to interstitial oedema.

Pulmonary Arterial Patterns: These depend on the amount of pulmonary blood flow which may be decreased in obstructive disease of the right ventricular outflow tract, and increased in left to right shunts.

The right pulmonary artery runs horizontally to the right in the mediastinum and as such it is invisible on P.A. view though on lateral view it may appear as an end-on vessel. Left pulmonary artery is visible because it traverses from front to back in the hilum.

The descending pulmonary artery, the main branch of the main pulmonary artery is visible in P.A. view on both sides as it passes from its origin in the hilum downward and outward, lateral to the cardiac border. It is upon the thickness of the artery and the pattern of the distribution of peripheral arteries that the grading of plethora is done in the following three grades.

1+: The size of the descending pulmonary artery is greater than 16 mm which is the maximum permissible normal limt. 2+: The size of the descending artery is increased and tapers evenly to the periphery 3+: The torential blood flow has stretched the peripheral muscular vessel leading to their abrupt narrowing at segmental level so that the even narrowing is lost, though the normal ratio between the central and peripheral vessel is maintained within normal limits of 5:1. In pulmonary arterial hypertension associated with pressures exceeding 50/25 mmHg there is marked dilatation of central vessel upto the segmental level thereby increasing the ratio of thickness of hilar vessel to peripheral vessel to 7:1. Pulmonary oligemia is characterised by diminution in shadow of both arteries and veins which makes the lung more radiolucent. No pulsation of the hilar vessels is seen on image-intensification flouroscopy.

On the basis of the pulmonary vaculature, the cardiac chamber predominently affected, the presence or absence of cyanosis, congenital heart diseases can be divided into twelve subgroup: (Table I).

It must be admitted that the possibility of reaching an exact diagnosis by plain X-Ray of chest alone is much more in acquired heart disease than congenital heart disease where one has to be satisfied by placing them in one of the above twelve subgroups (Table I) as the anatomical abnormalities may be multiple. How-

ever, the radiographic picture coupled with other clinical features and the frequency of occurrence of a disease makes possible very sophisticated diagnosis. The X-Ray chest is the cheapest and rupee for rupee most useful non-invasive cardiac diagnostic test available.

References

1. Heart Disease Silber, E.N. and Katz L.N. Mac millan 1977.
2. The Heart edited by Hurst, J. Willis (et. al.) Mc Graw Hill, 1978.
3. Roentgen Signs in clinical Practice by Meschan Isadore. Vol. II, Saunders, 1966.
4. Clinical Cardiac Radiology by Jefferson, Keith and Rees Simon. Butterworths, 1978.
5. Clinical Anatomy of the Heart, by Walmsley, Robert IIIrd Watson, Hamish Churchill, 1978.

———:o:———