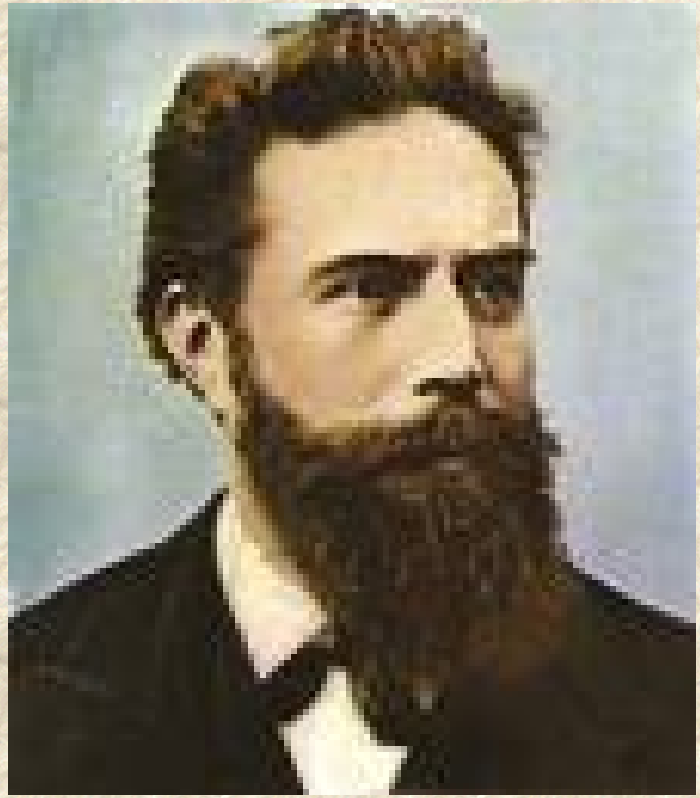
The Chest Xray and Electrocardiogram

Roentgen/Einthoven

The State of Their Art

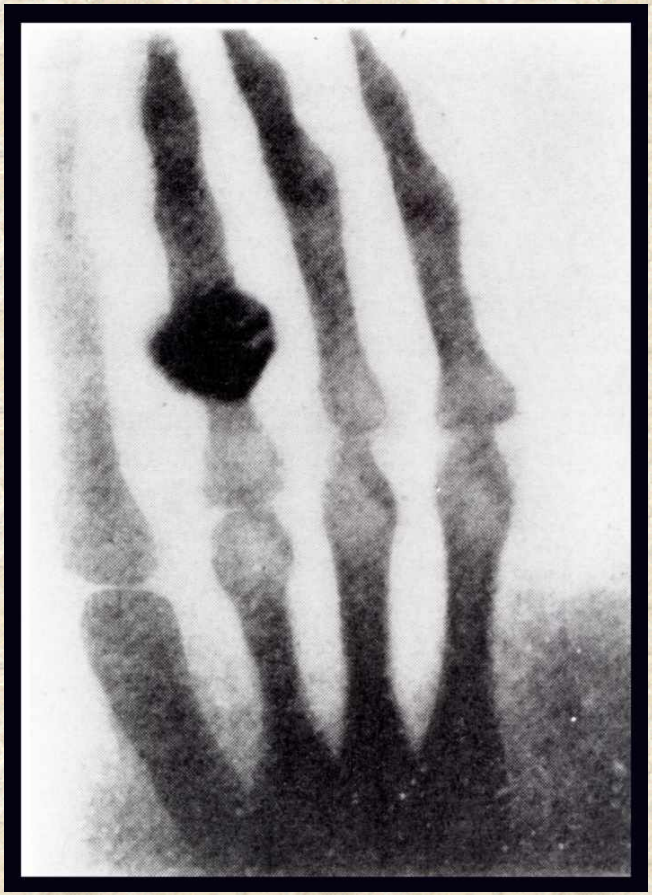


Wilhelm Conrad Rontgen

Nobel Prize in Physics 1901

1995 100th Anniversary

Rontgen's X-ray



Photograph of the bones in the fingers of a living human hand.
The third finger has a ring upon it. W. K. Rontgen 1896

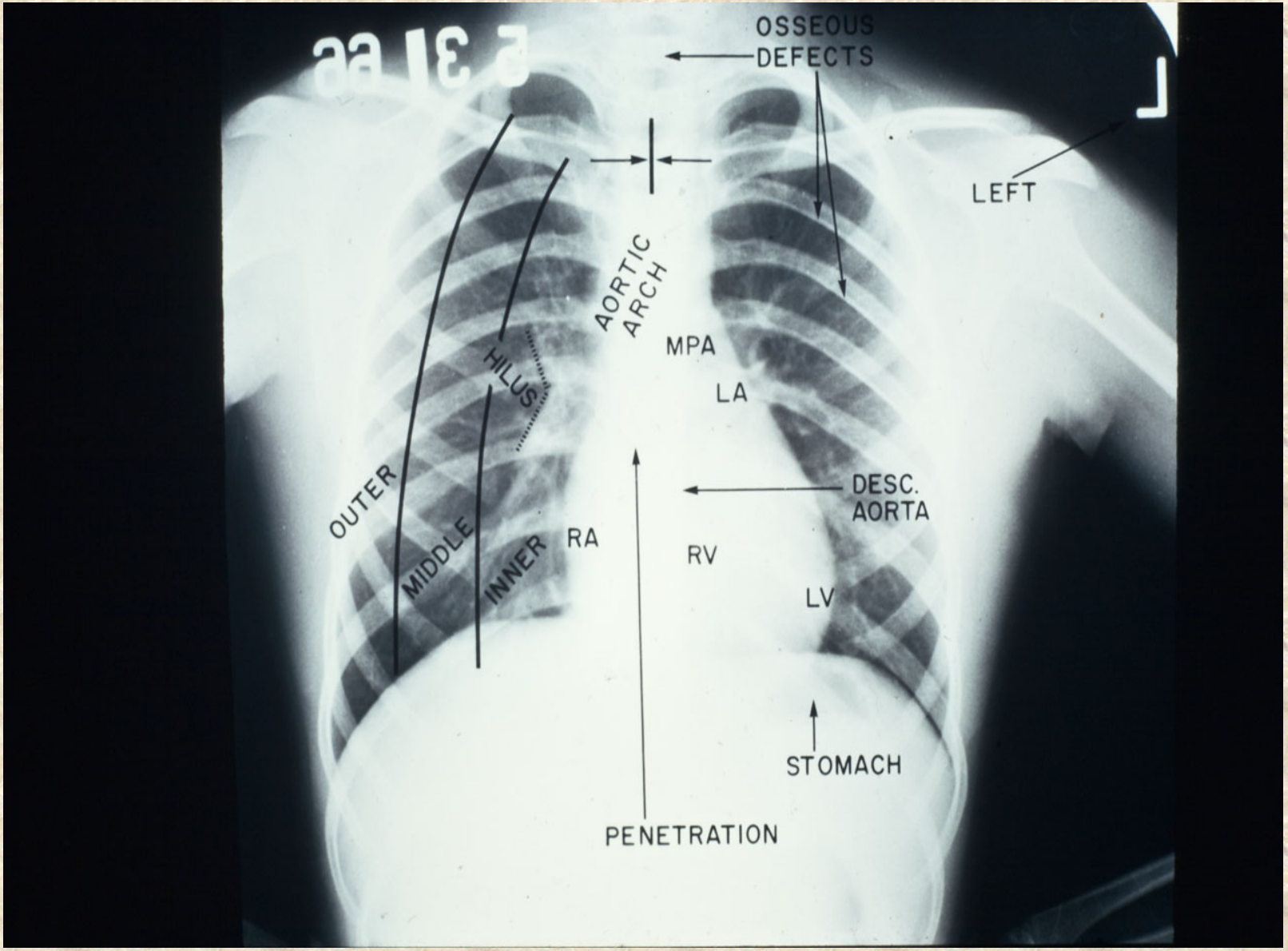
Experimental X-Ray Digital Detector for Investigation of Paintings

Radiological investigations constitute a fundamental tool for investigation of the inner structure of works of art.

Chest X-ray in Congenital Heart Disease

- Age and sex
- Right/left orientation
- Positions and malpositions -- above and below the diaphragm, thoracic and abdominal *situs*
- The bones
- Extrapulmonary soft tissue densities
- Intrapulmonary soft tissue densities – vascular and parenchymal
- The great arteries and great veins
- The atria
- The ventricles or ventricle

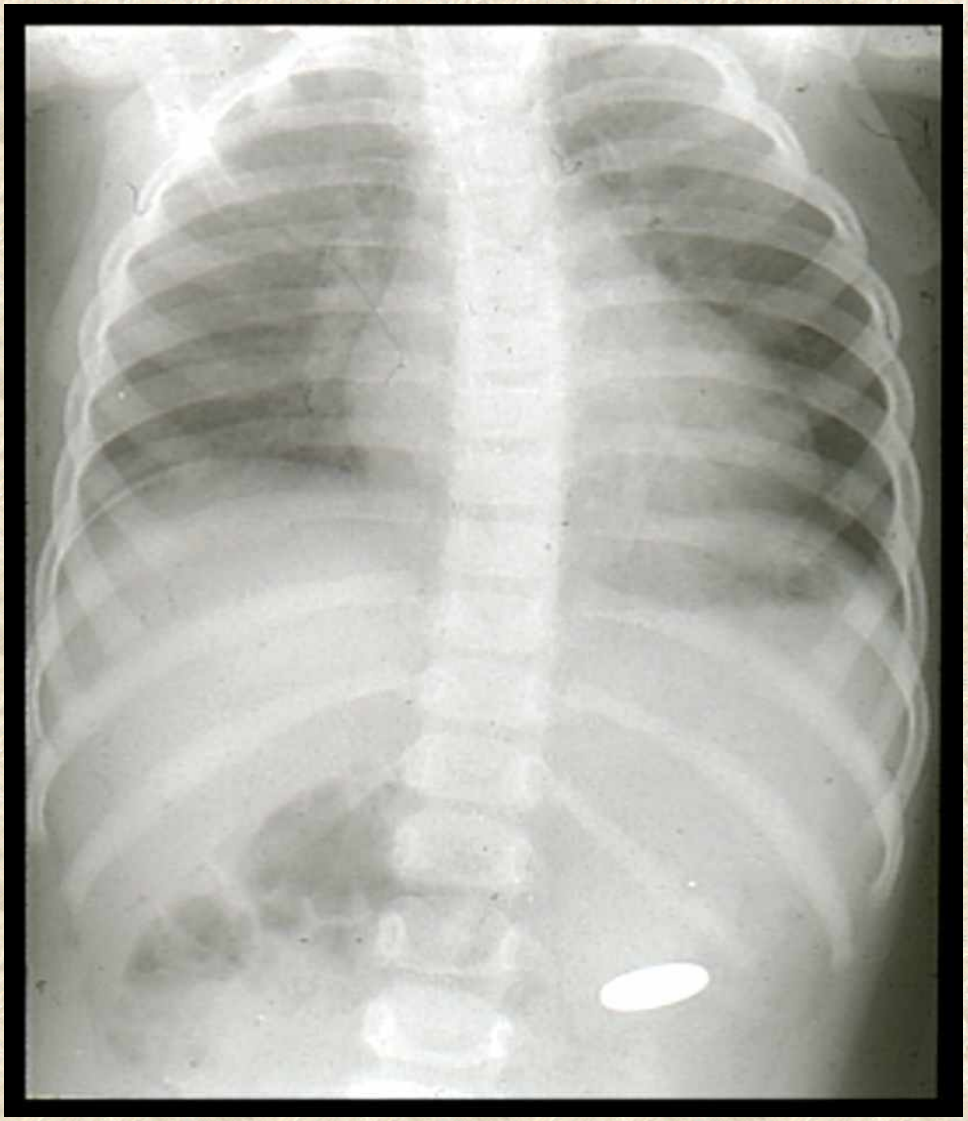
Xrays Should be Read, Not Looked At



Positions and Malpositions

Above and below the diaphragm.

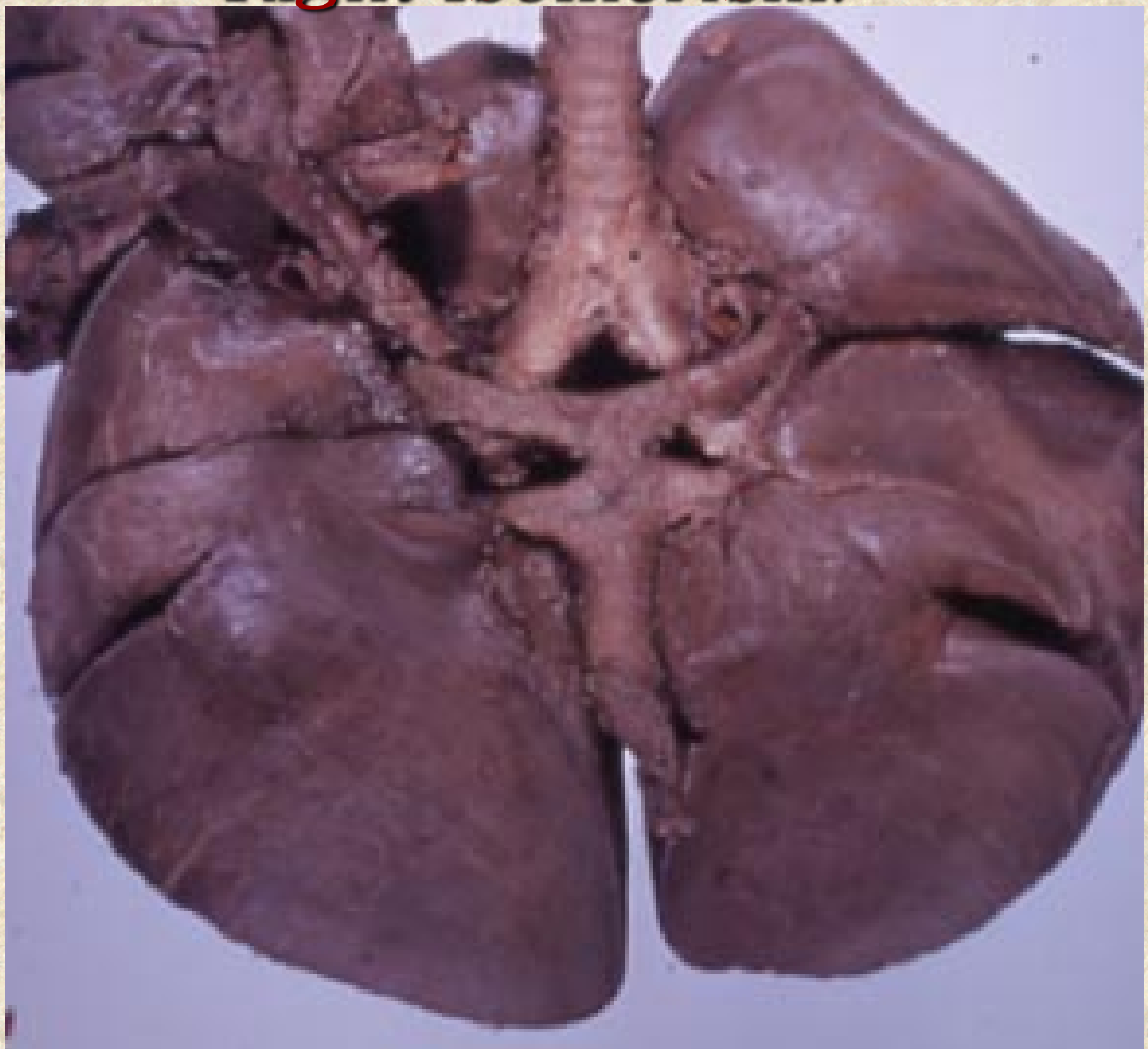
Thoracic and abdominal *situs*.



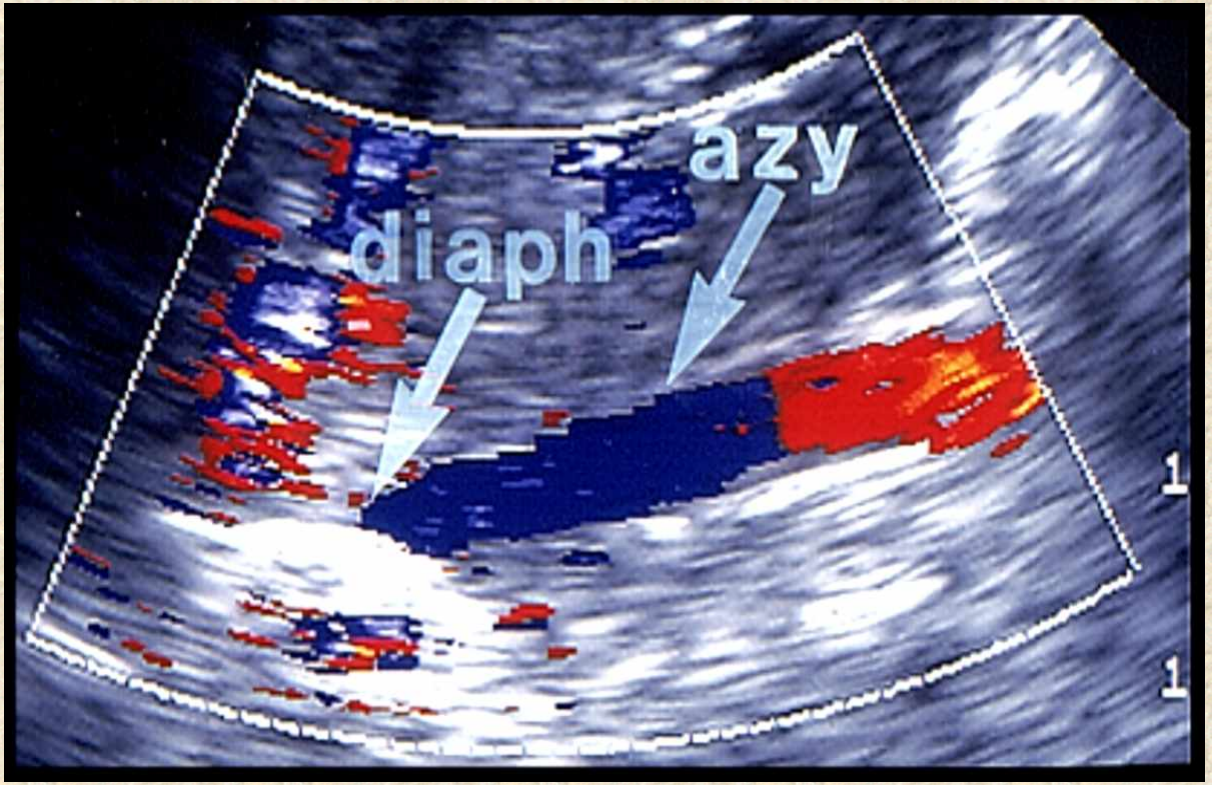
Transverse Liver

Asymmetric Right & Left Bronchi

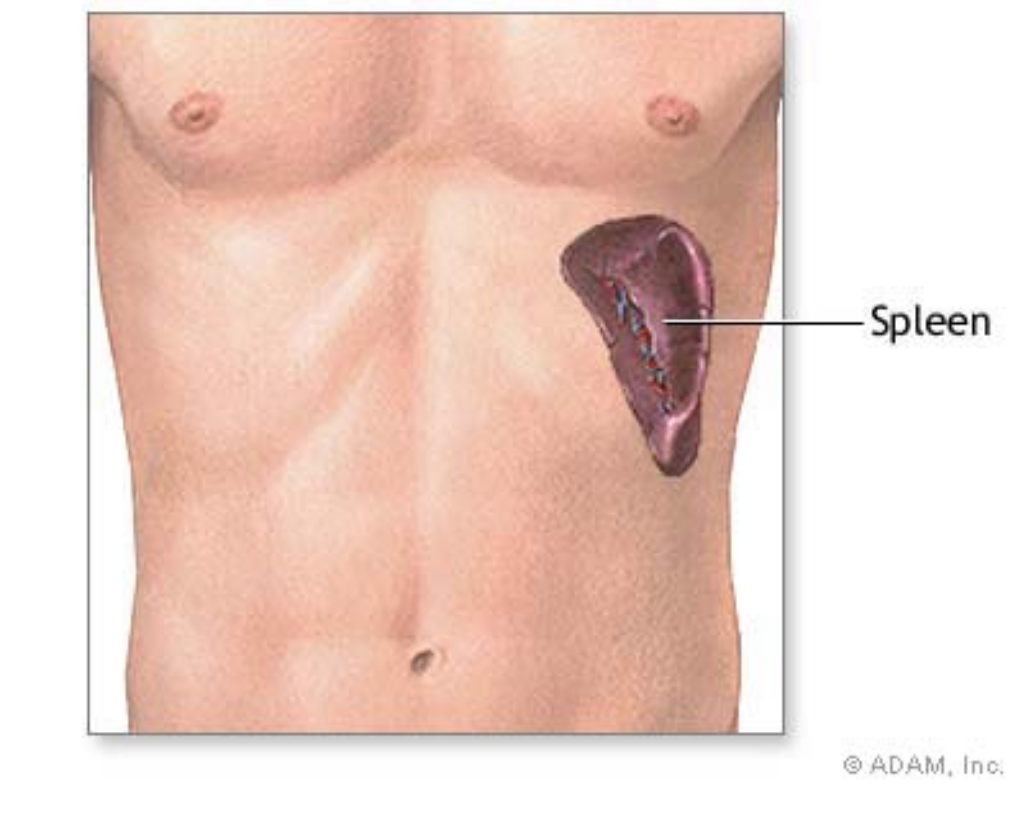
Symmetric Right Bronchi. Bilateral Trilobed Lungs. Right Isomerism.



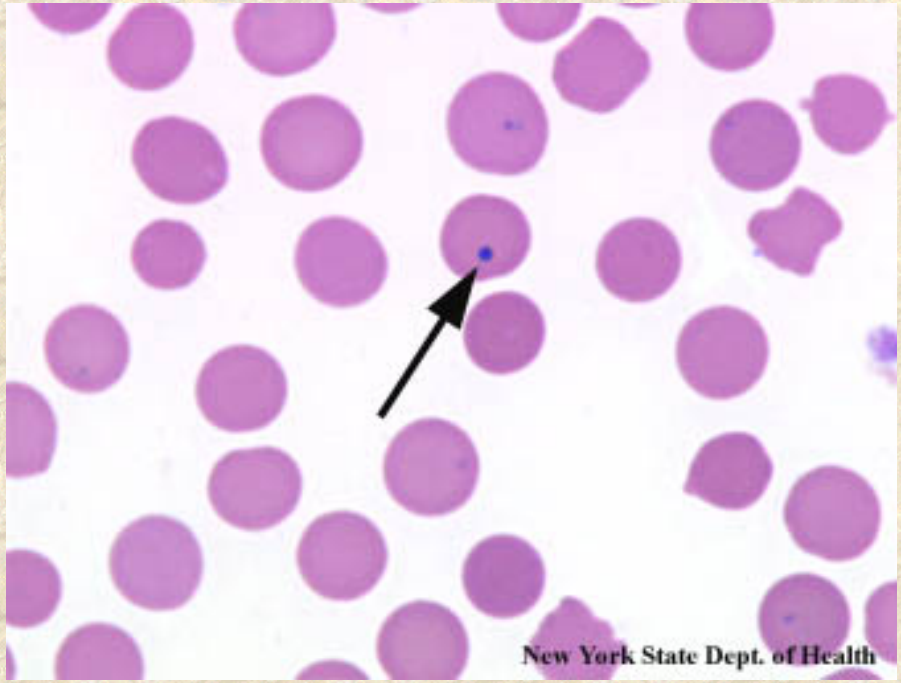
Symmetric Left Bronchi, Bilateral Bilobed Lungs, *Left Isomerism*



The Spleen. The Body's Only Unilateral organ.



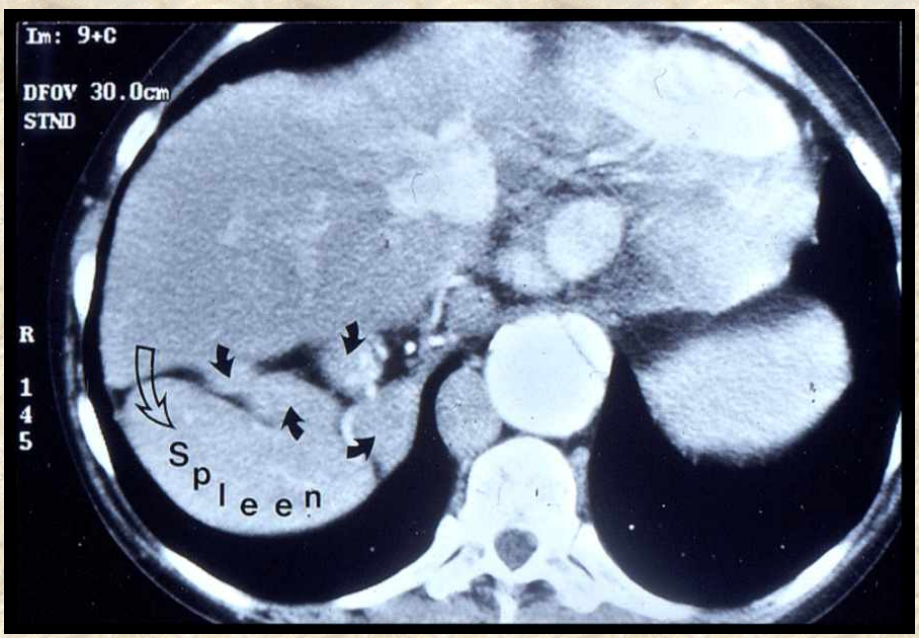
Right Isomerism
No Left Side, No Spleen
Asplenia

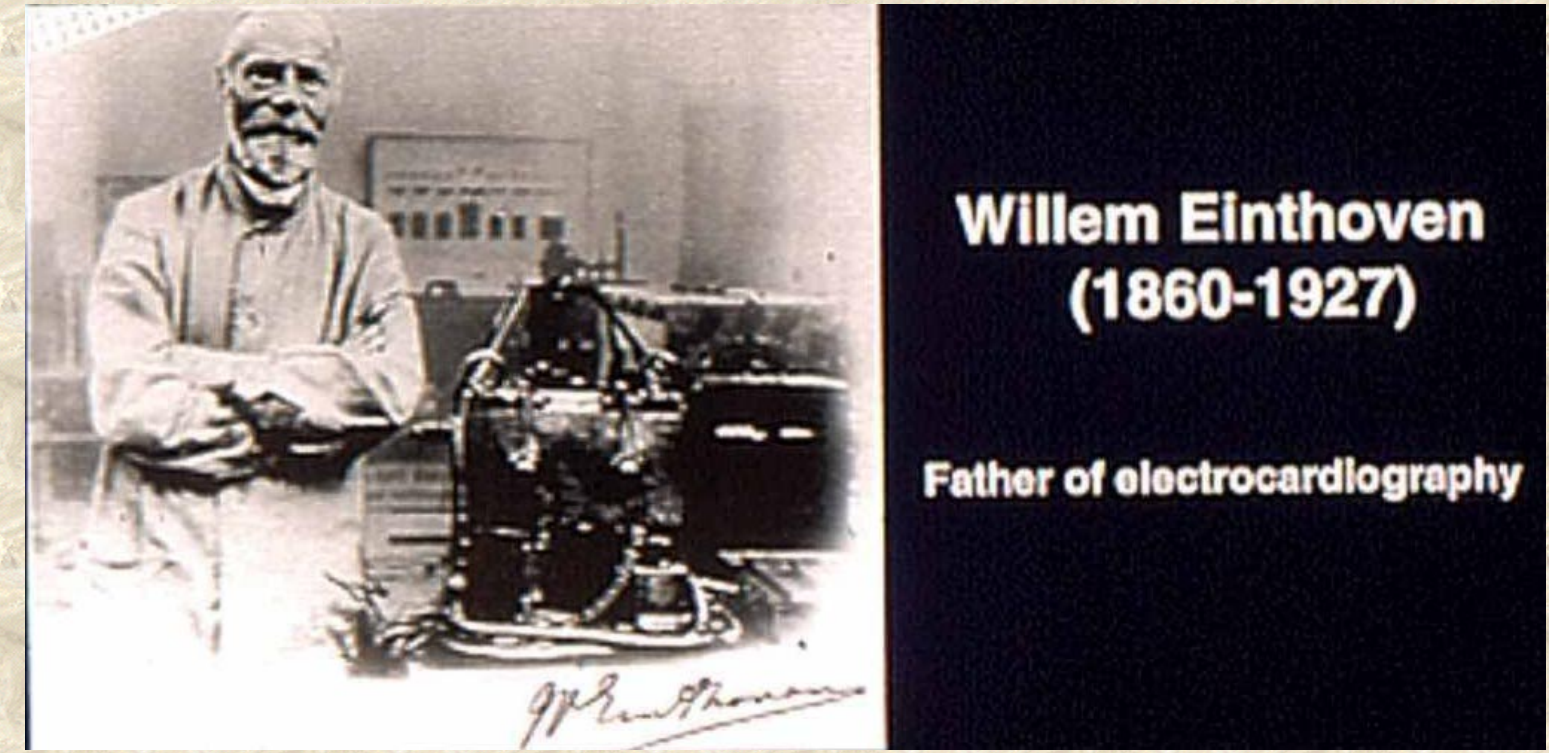


Howell Jolly Bodies

Bilateral Left-sidedness Polysplenia

Normal Spleen Plus Accessory Spleens





Einthoven W. Uber die form des menschlichen neurosurg. Pflugers Arch 1895

The Electrocardiogram

Many brilliant minds have contributed to the development of electrocardiography as a clinical science. The early history (1900-1945) was dominated by Professor Willem Einthoven in the Netherlands, Sir Thomas Lewis in England and Dr. Frank N. Wilson in the United States. These three pioneers laid the foundation for modern electrocardiography.

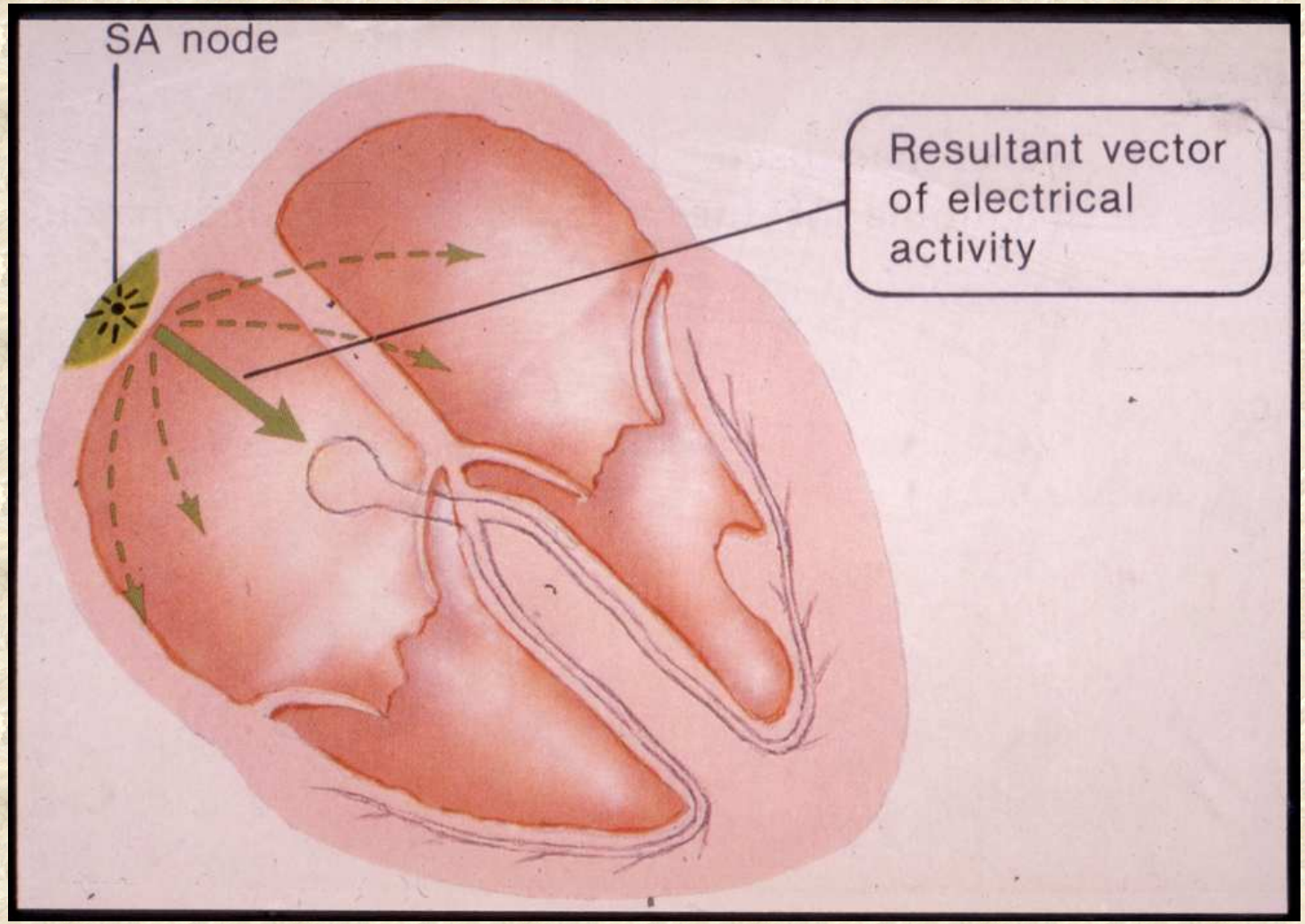
Charles Fisch, The ECG Centennial

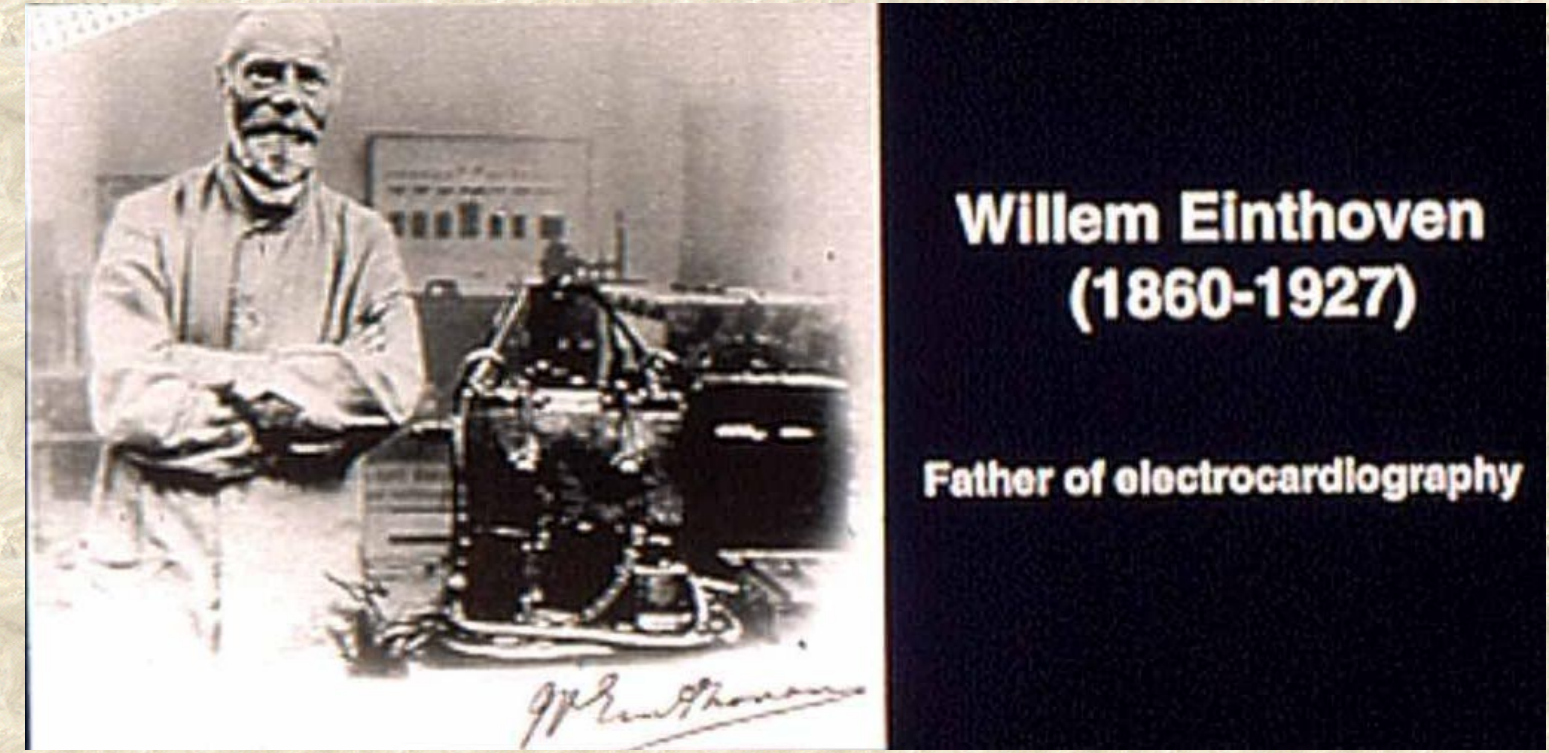
The Electrocardiogram

- P wave -- direction, morphology, duration, rhythm.
- PR interval -- duration.
- QRS -- duration, axis, direction of depolarization, amplitude, morphology.
- ST Segment -- deviation, morphology.
- T wave -- direction, morphology, amplitude, QT interval.
- U wave,

The Sinus Node

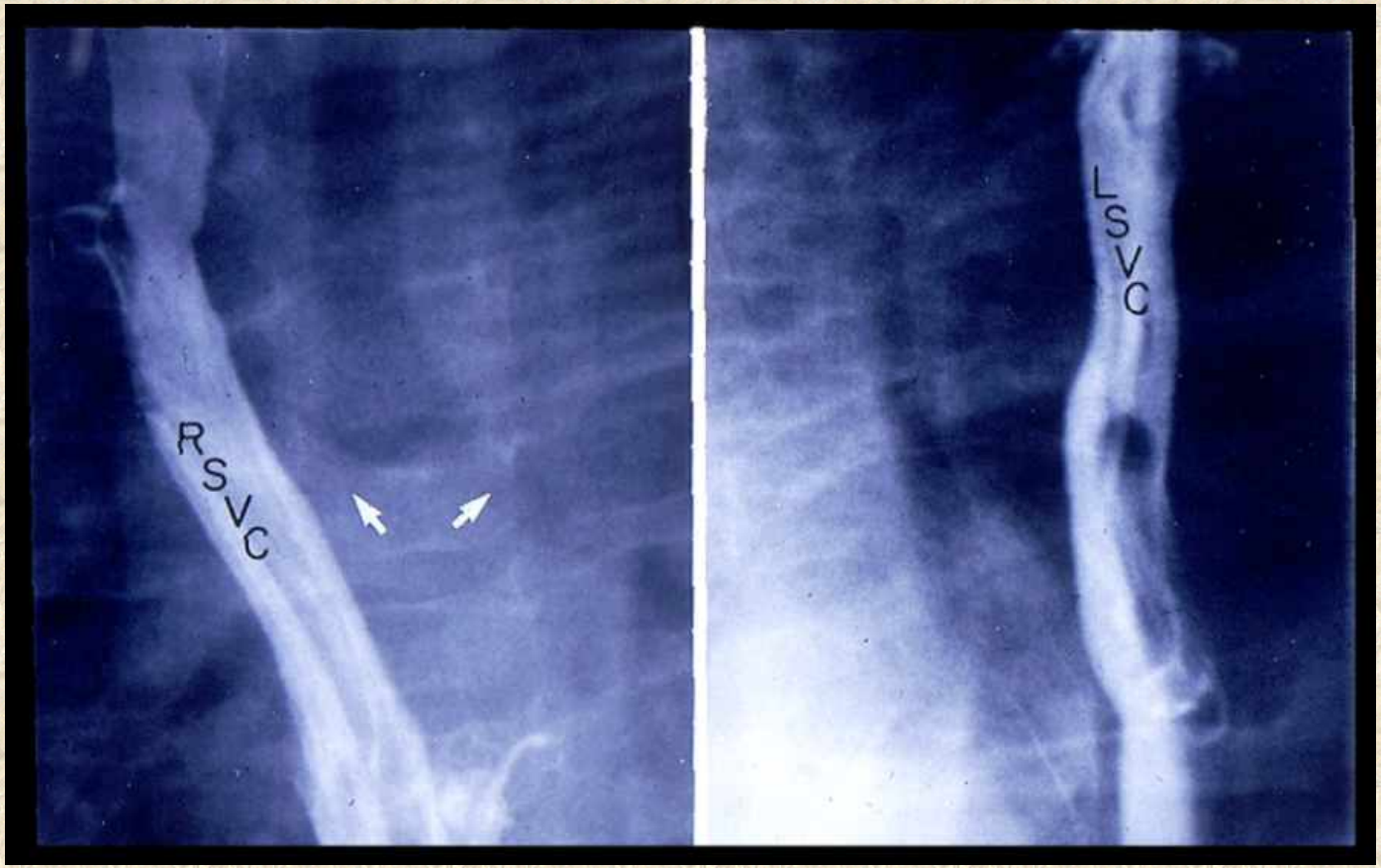
Junction of a Right SVC and a Morphologic Right Atrium



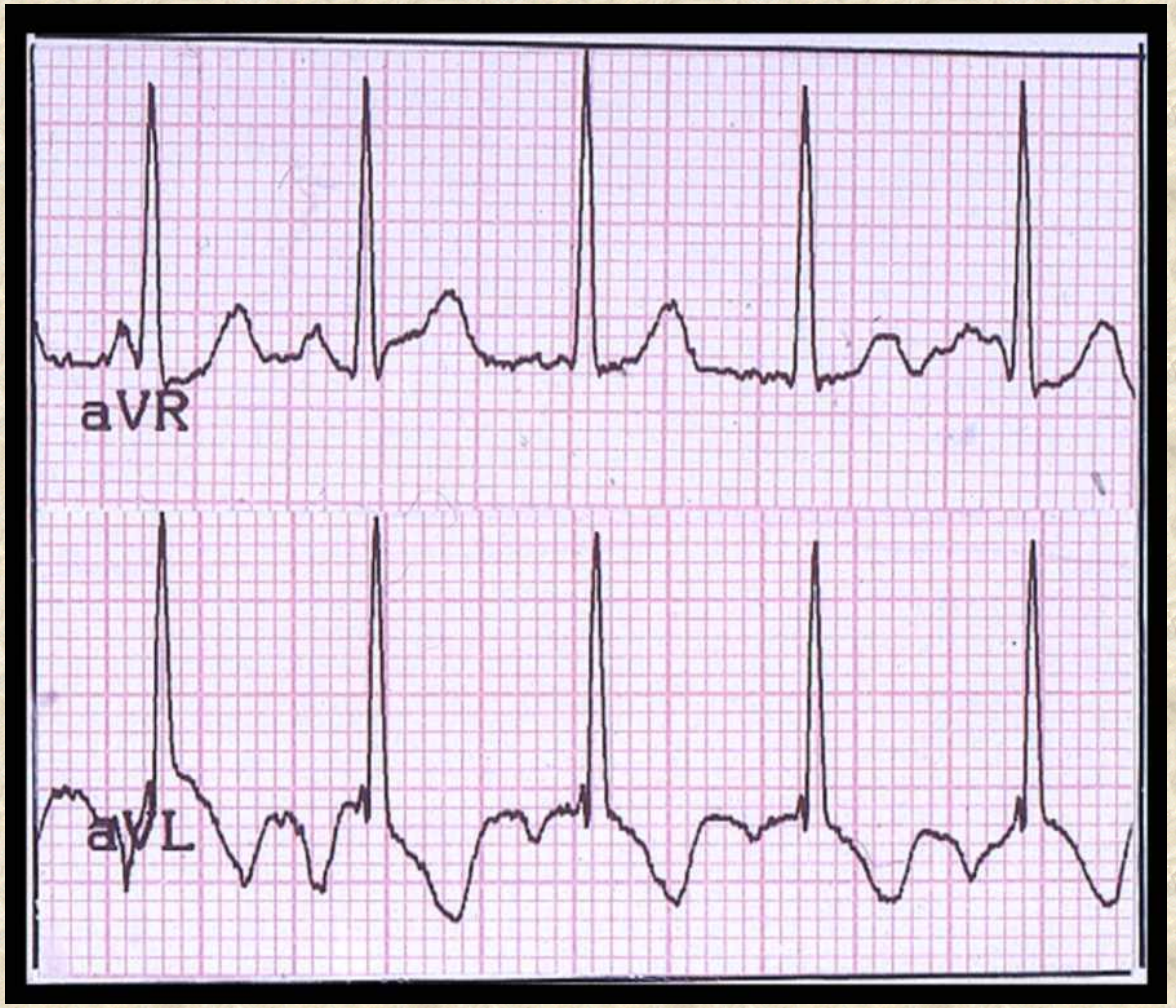


Einthoven W. Uber die form des menschlichen neurosurg. Pflugers Arch 1895

Left Isomerism. Bilateral SVC's. No RSVC/RA Junction. No Sinus Node



No Sinus Node. No Sinus Rhythm

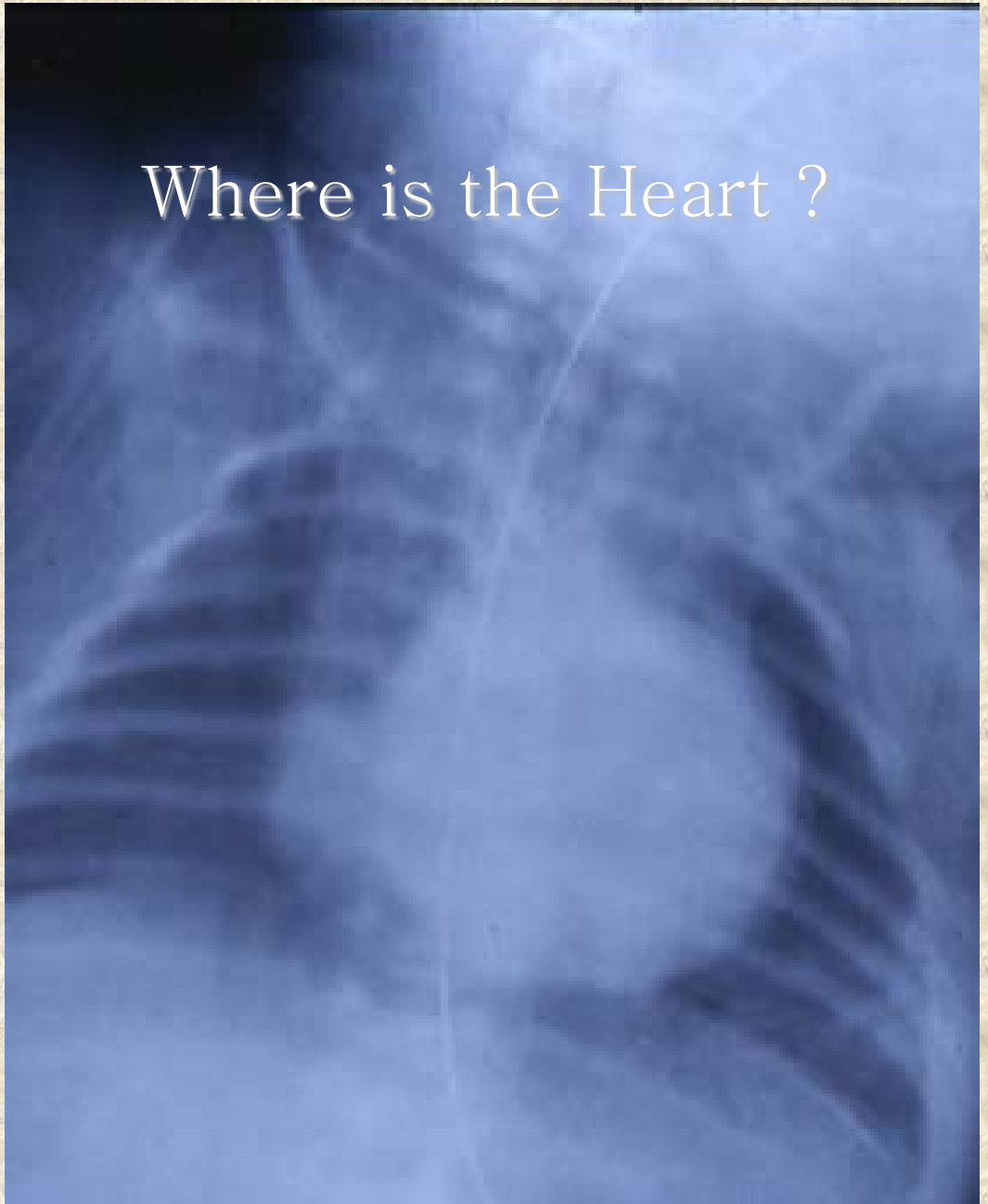


Misplacements of the Heart

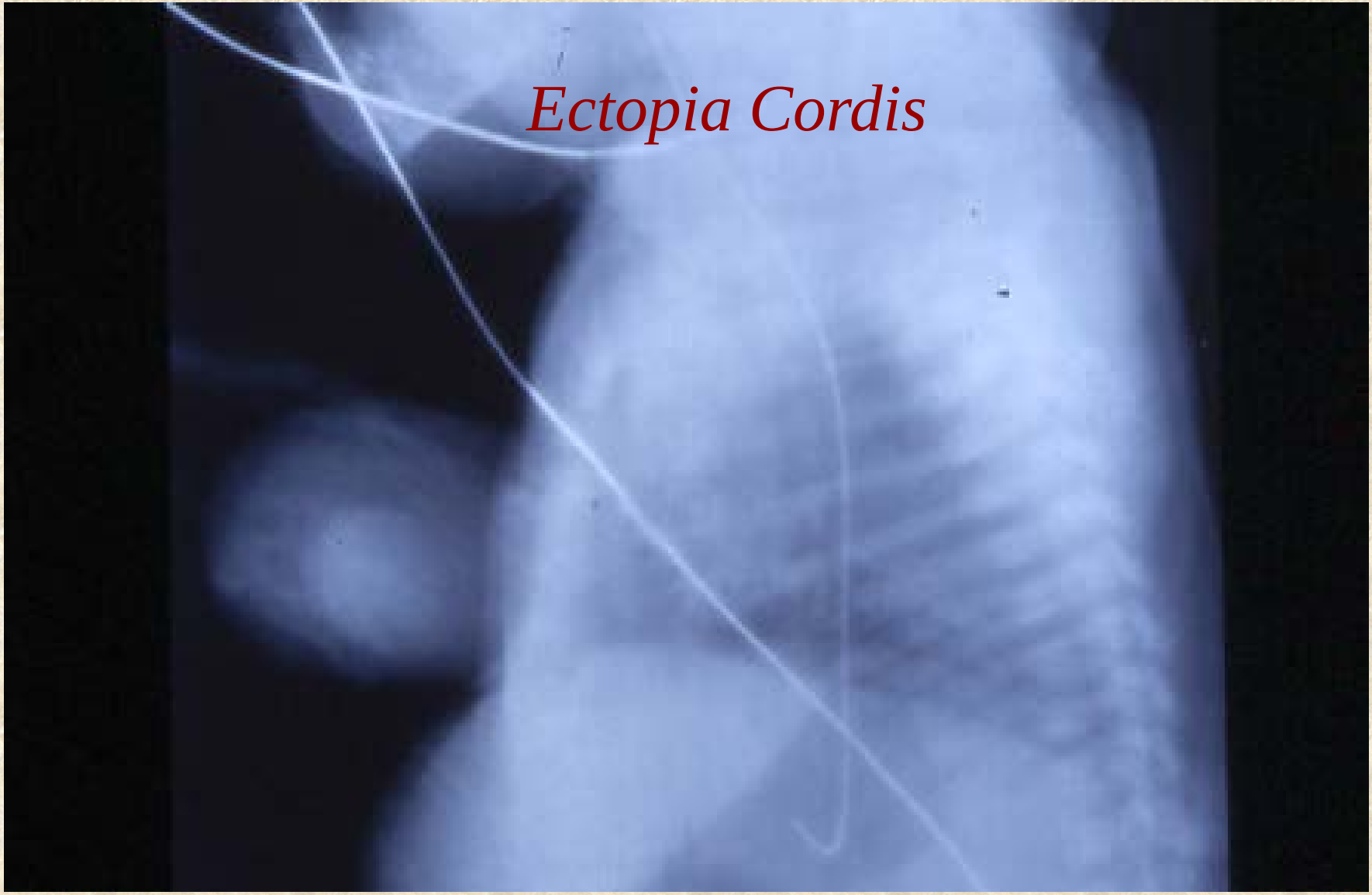
The heart may be congenitally misplaced in various ways, occupying either an unusual position within the thorax, or being situated external to that cavity.

Thomas B. Peacock 1858

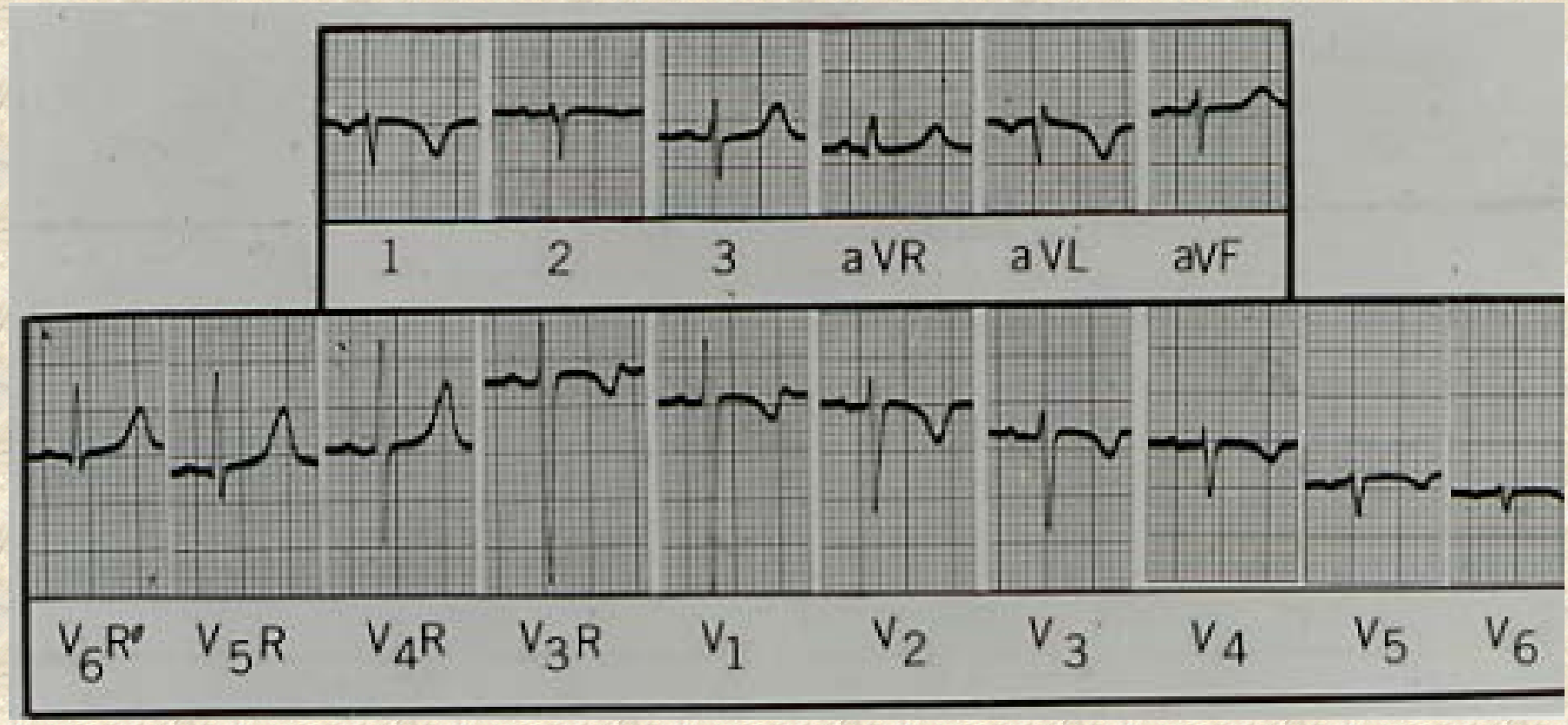
The Egyptians believed that the heart was the seat of personal and moral integrity. If the heart were not in its right place, the individual would be beside himself.


Where is the Heart ?

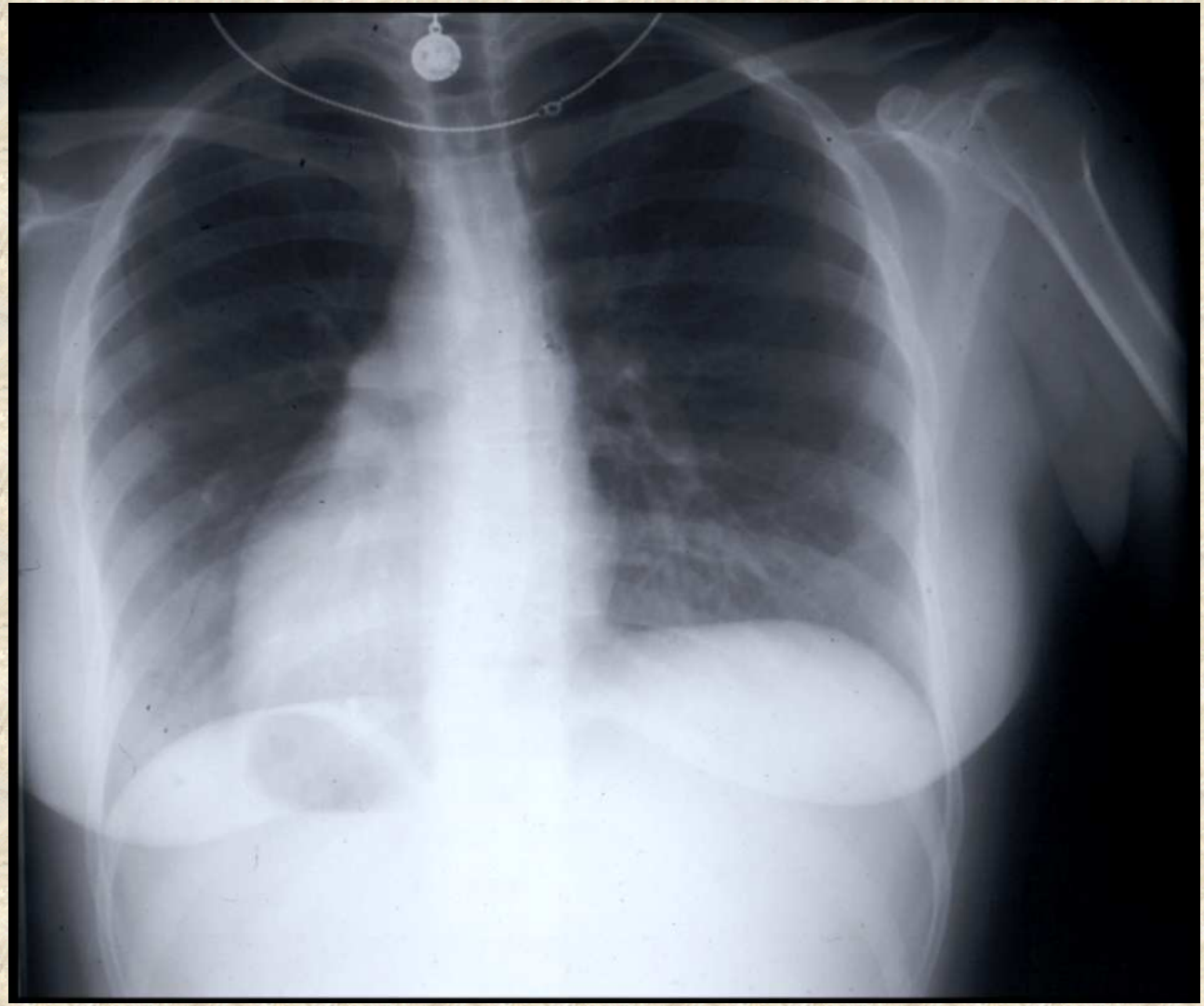
Ectopia Cordis



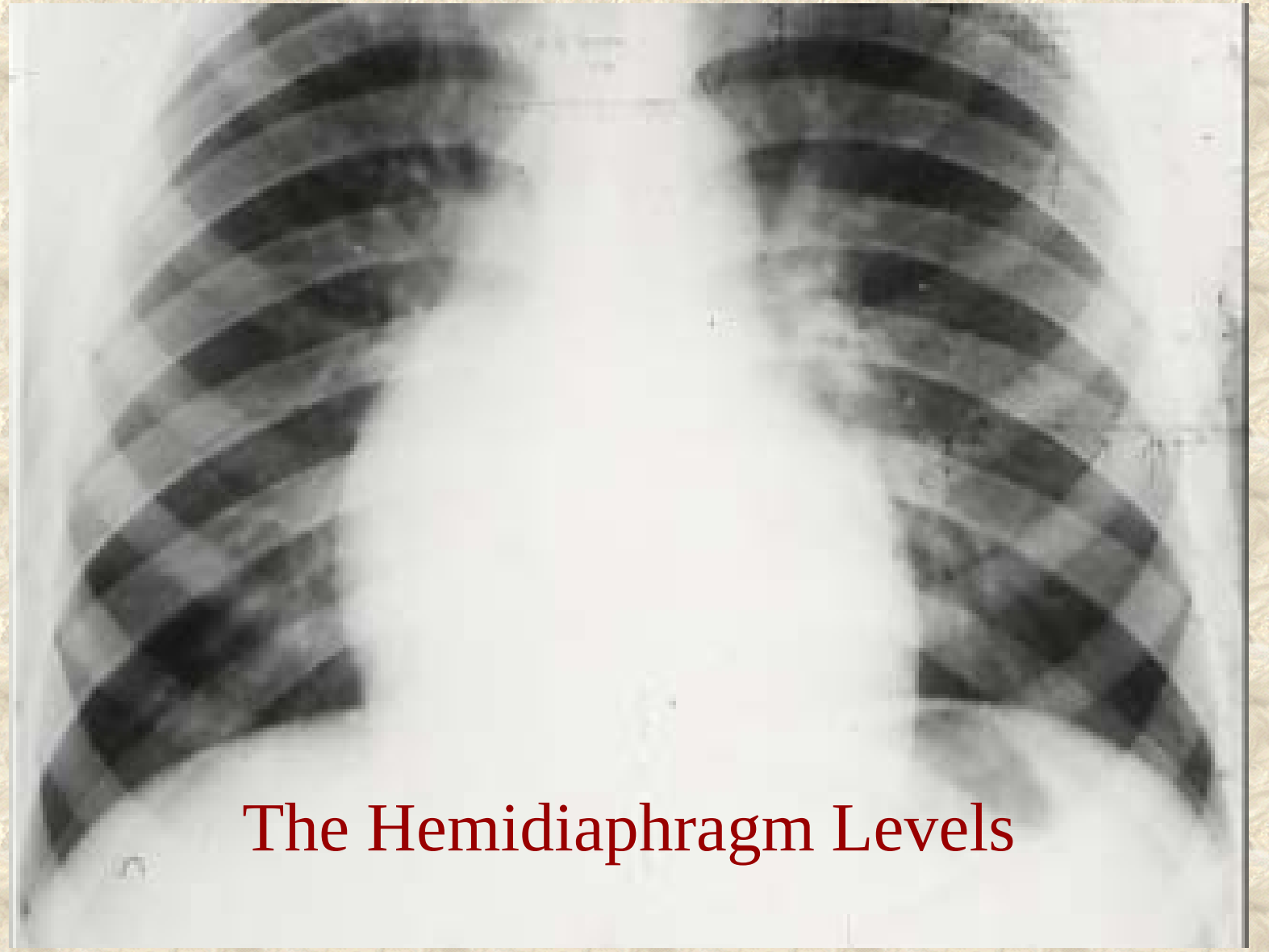
What Side Are You On ?



Situs Inversus With Dextrocardia

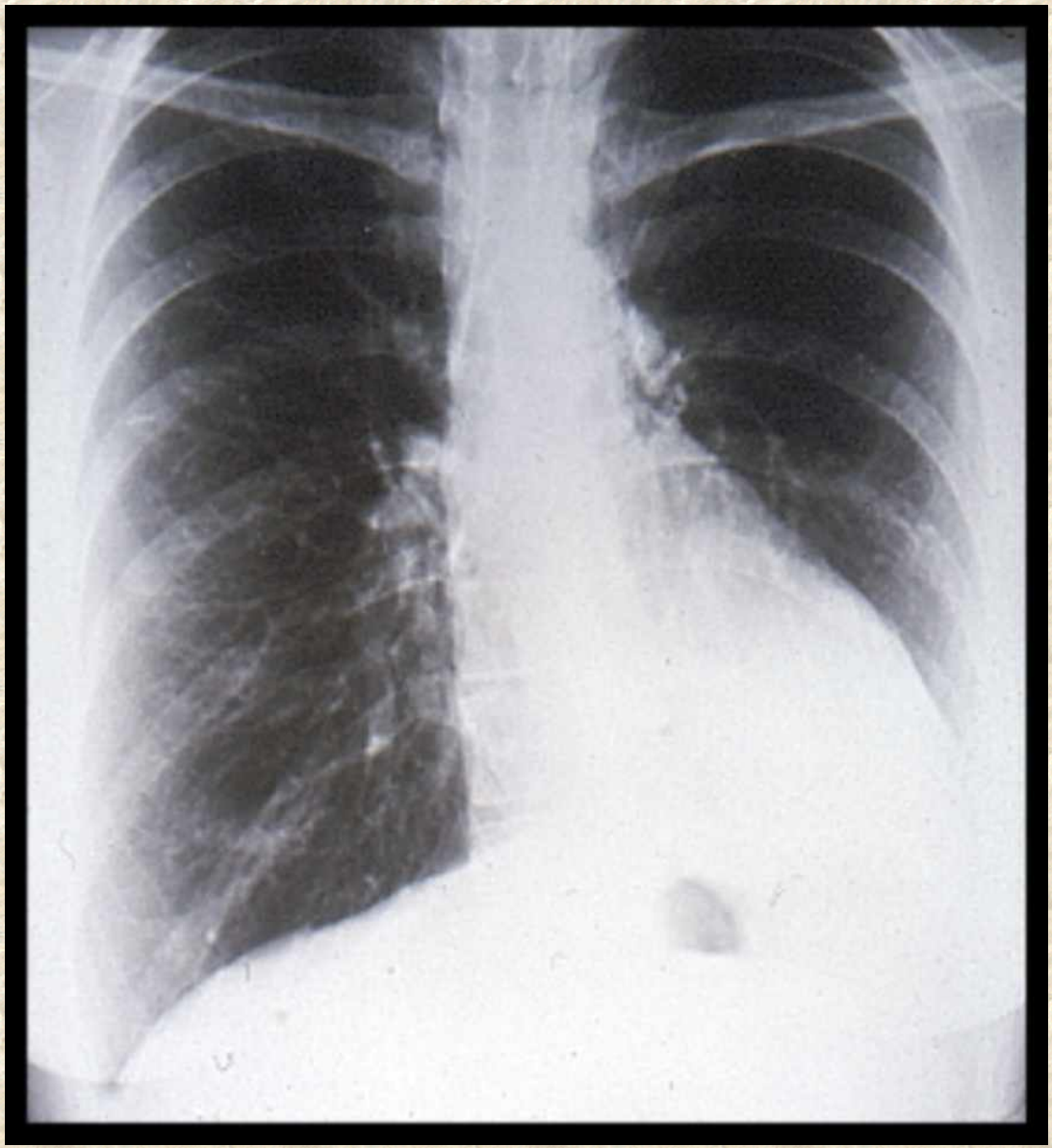


Now What Side Are You On?

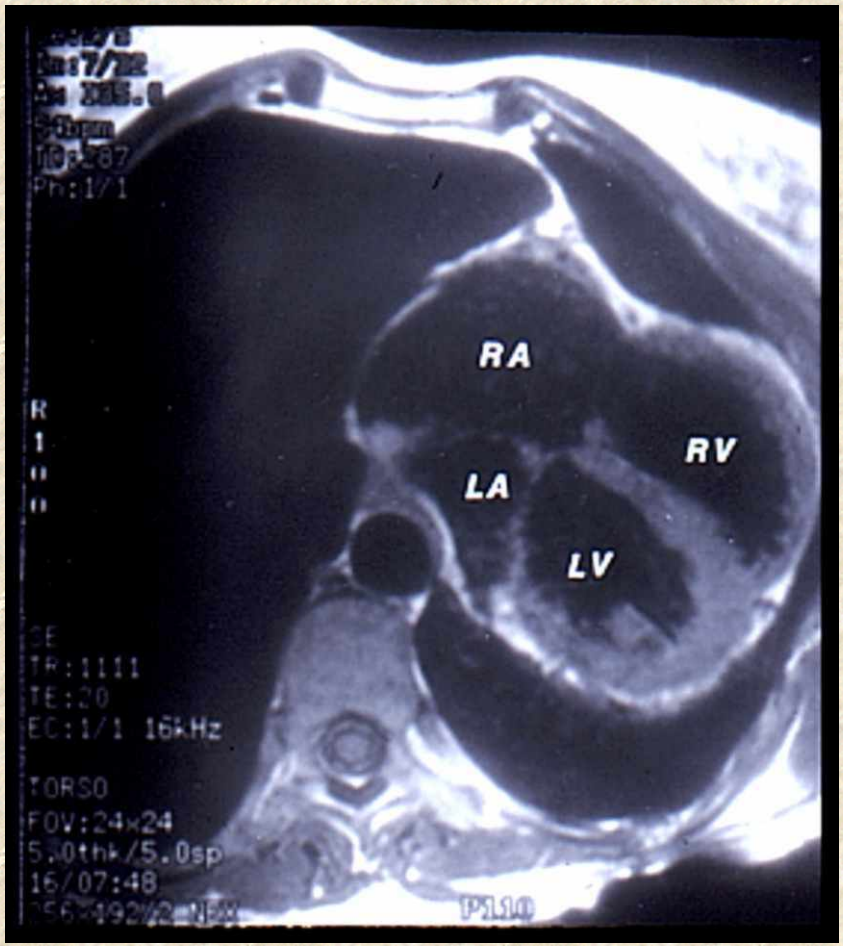


The Hemidiaphragm Levels

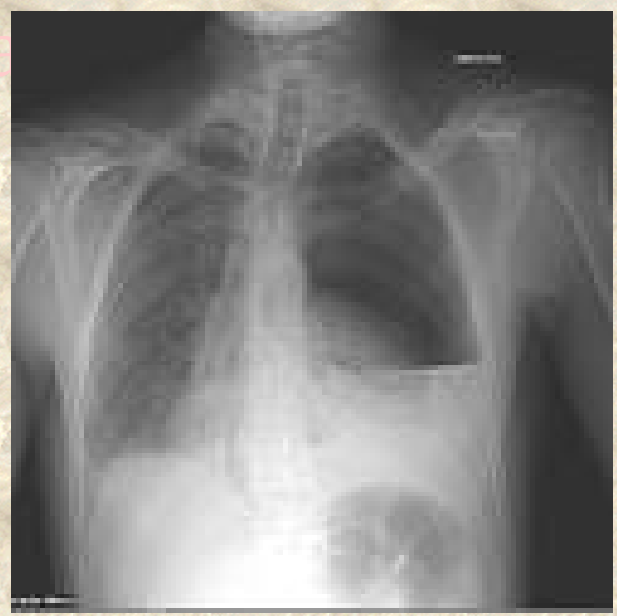
Left of Center.



Congenital Complete Absence of the Pericardium



Catamenial Pneumothorax



Recurrent pneumothorax that coincides with the menstrual cycle, described by Maurer in 1958, called catemenial pneumothorax by Lillington in 1972.

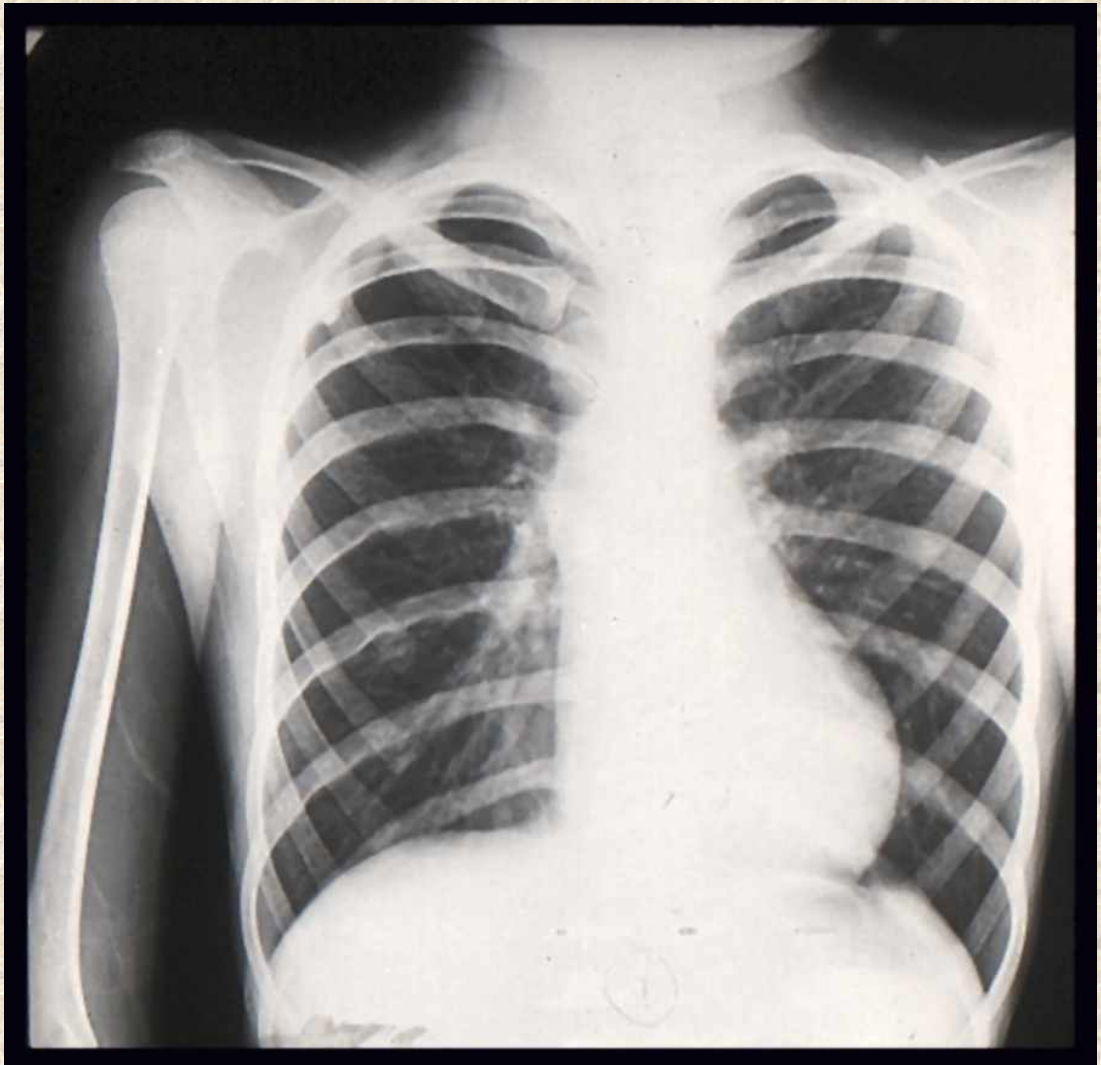
The Bones

A. Reynaud

1828

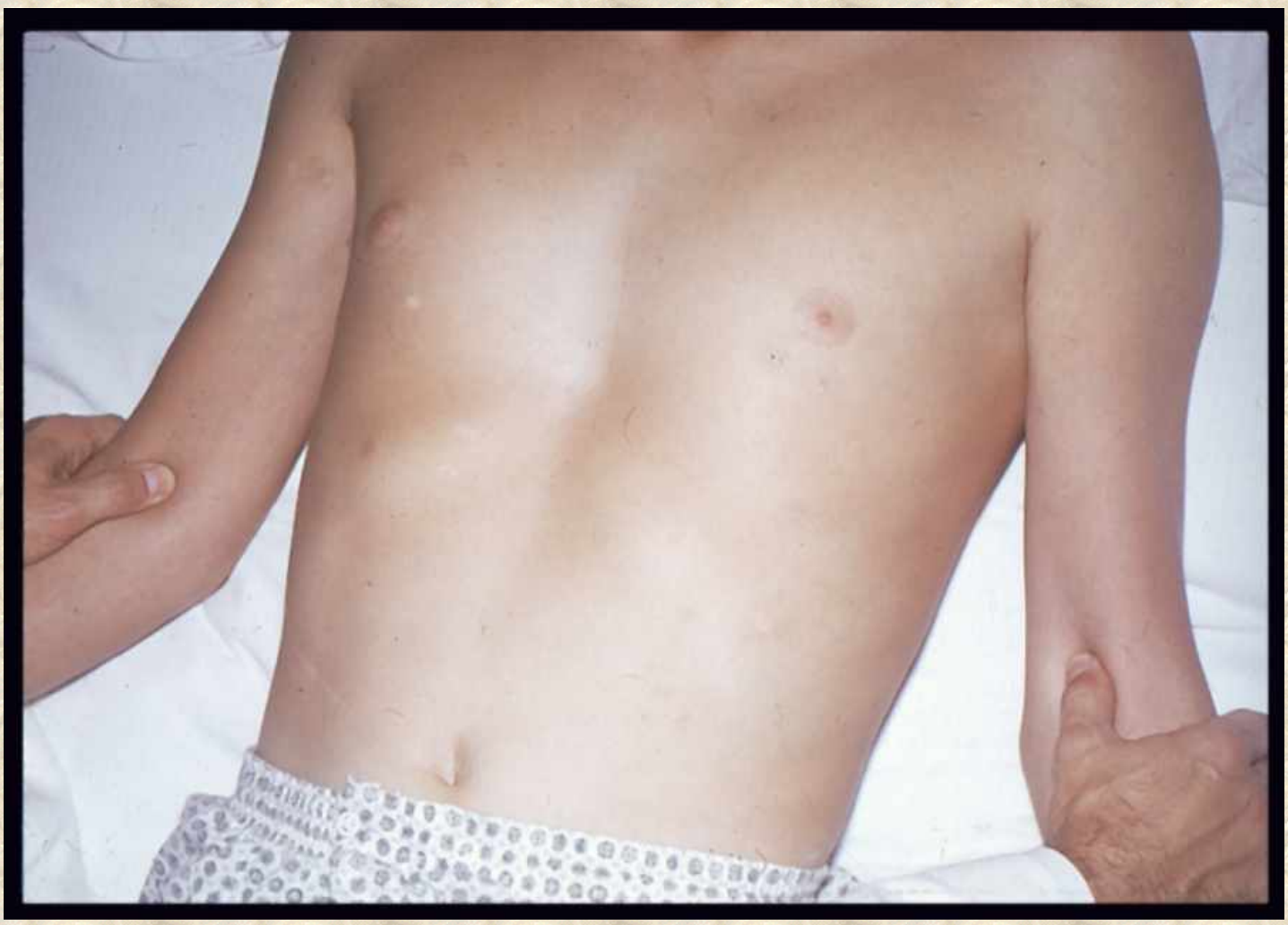
Bilateral Collaterals

Where are the collaterals?
Where is the coarctation?
Where is the rib notching?

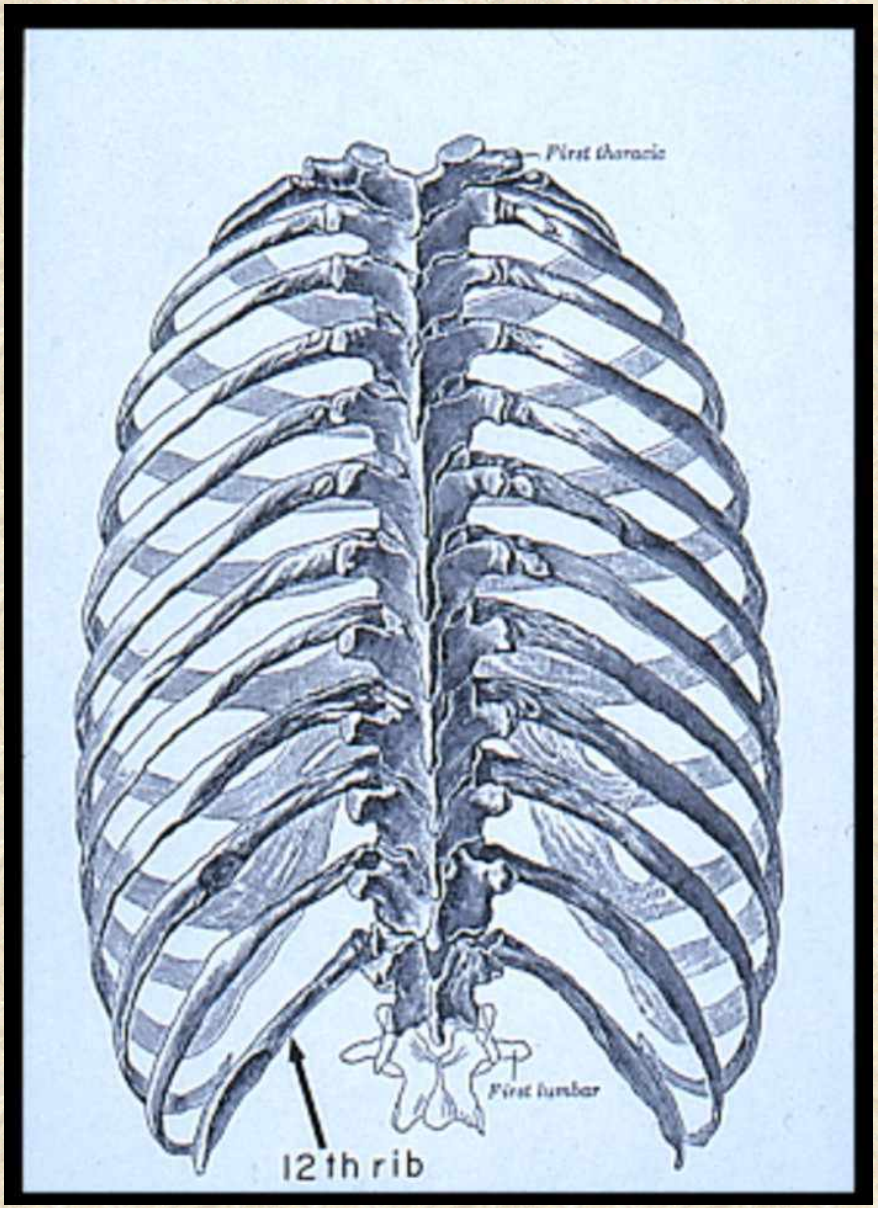


Obstructed Left Subclavian
Unilateral Collaterals
Unilateral Notching

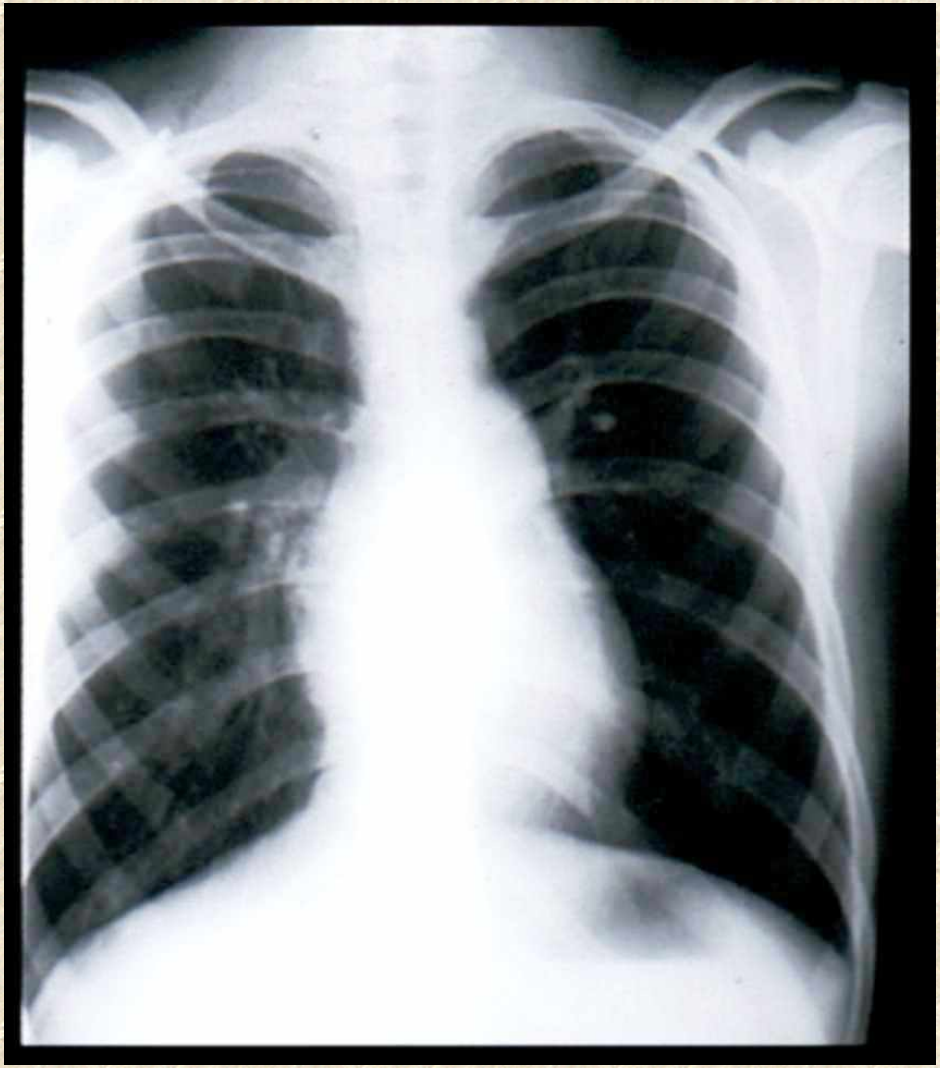
Absent Left Subclavian. Absent Left Brachial Pulse. Unilateral Notching.



Cheaper by the Dozen



Absent 12th Rib

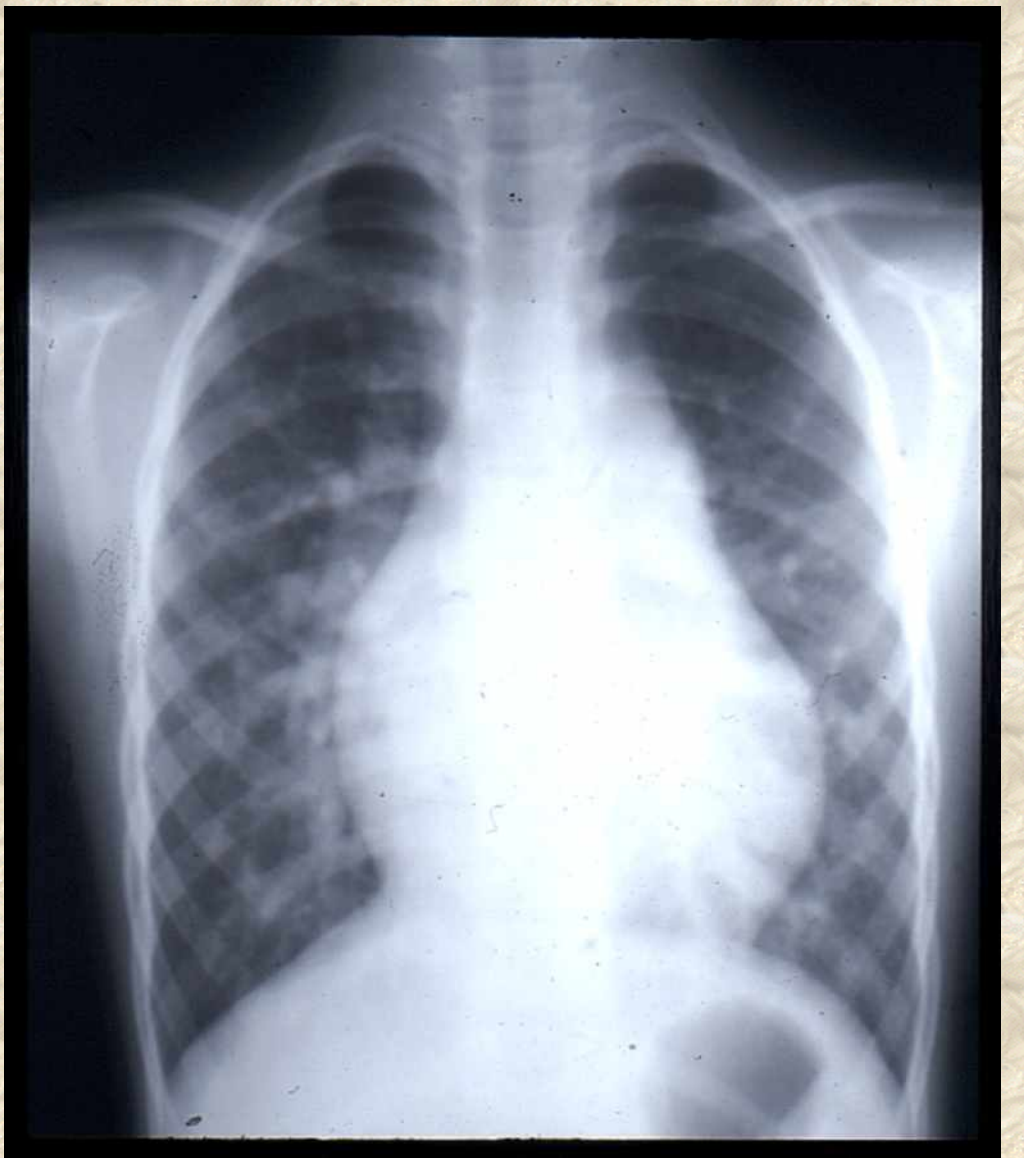


Down Syndrome

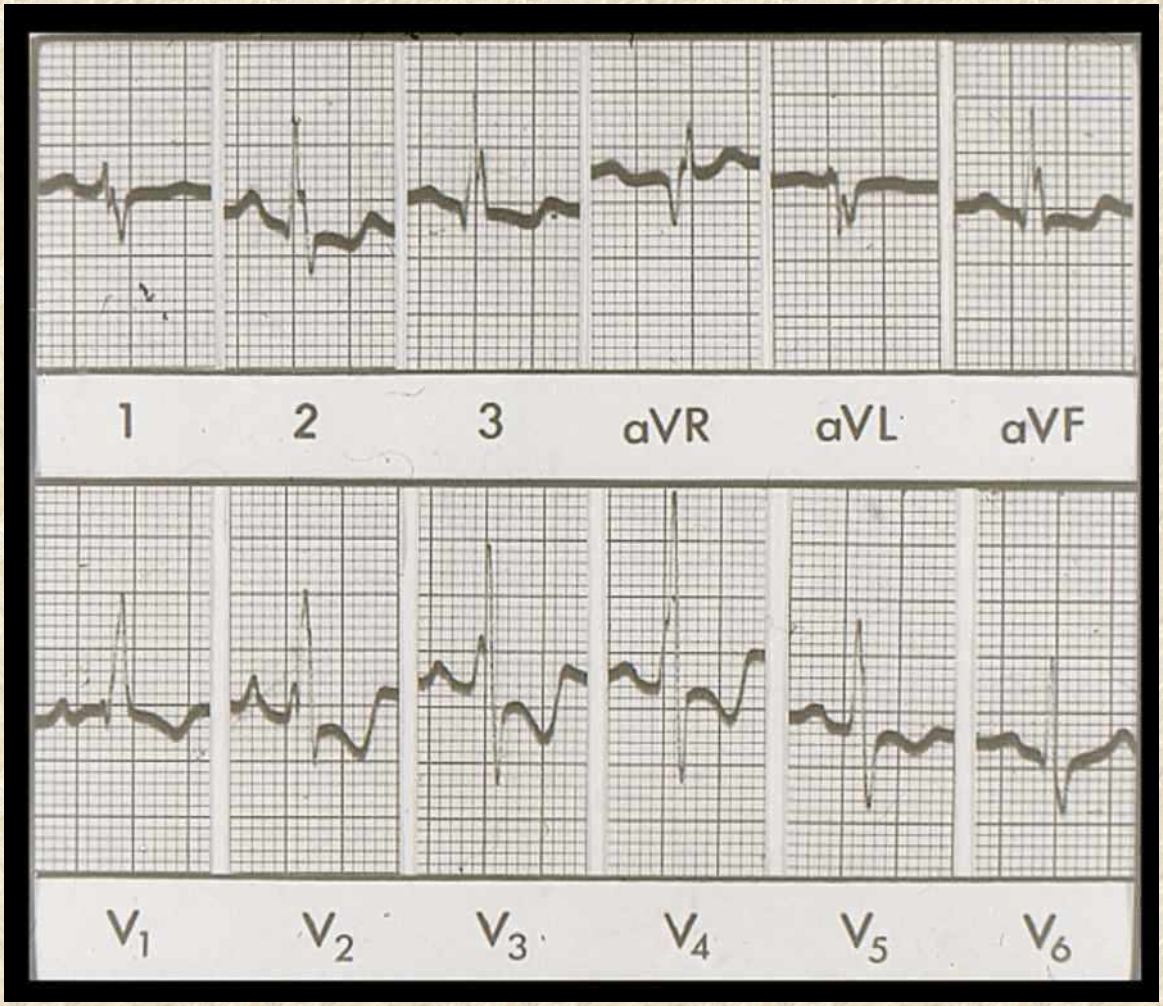
Intrapulmonary Soft Tissue Densities:

Vascular/parenchymal

Increased Pulmonary soft Tissue Densities
Where is the Shunt?



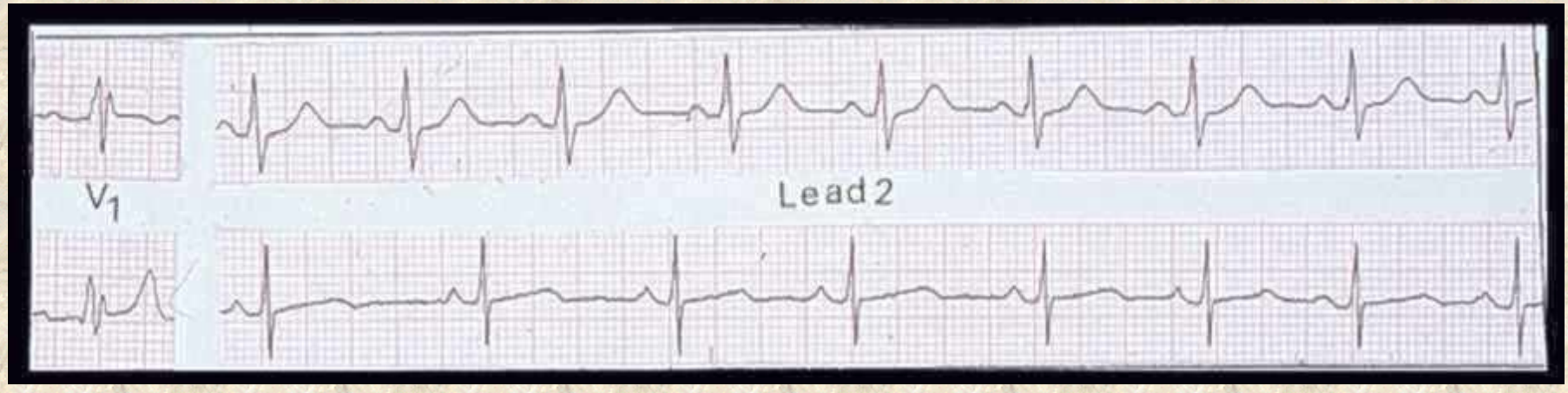
The Answer is Chrochetage



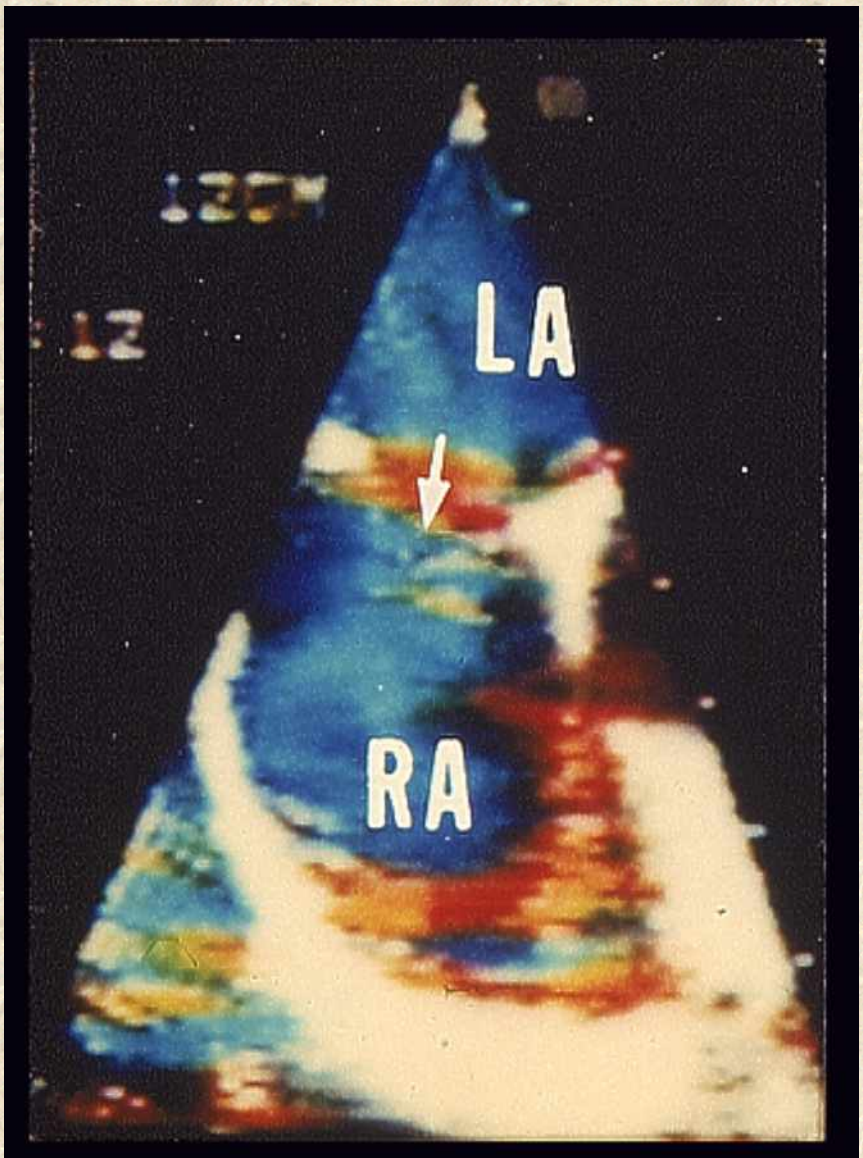
Sinus arrhythmia in children with atrial septal defect: An analysis of heart rate variability before and after surgical repair

Finley JP, et al. Br Heart J 1989

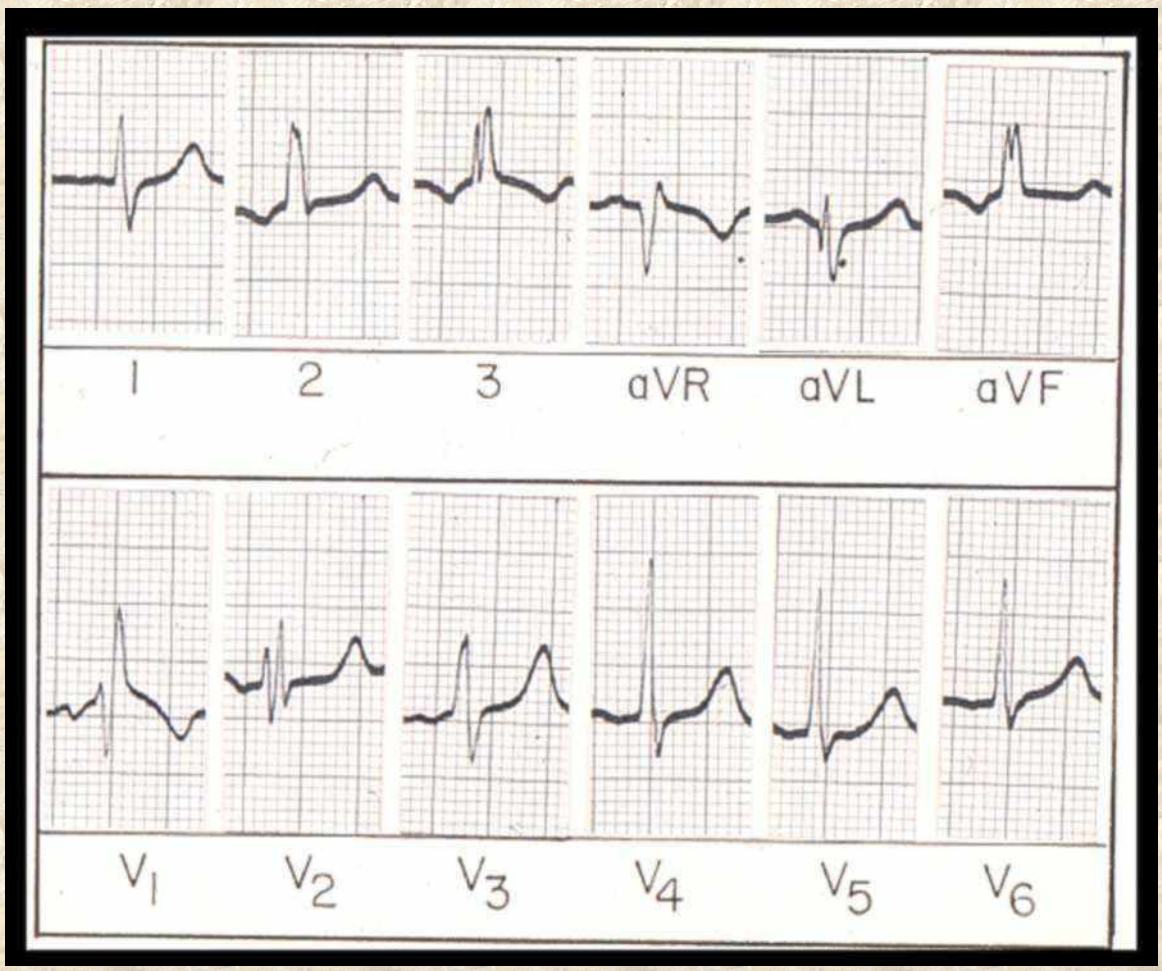
Secundum ASD
Before and After Closure



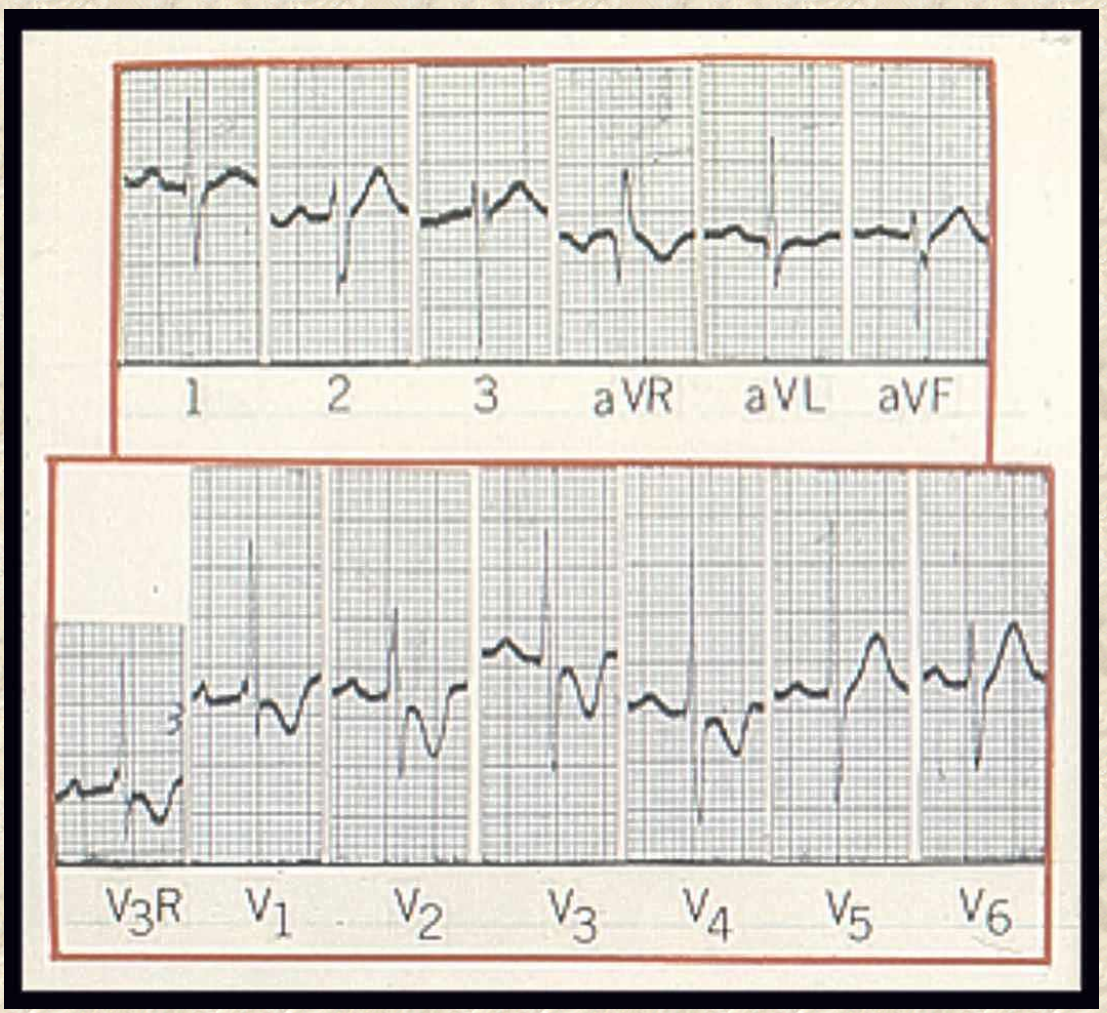
SVC Sinus Venosus ASD
Absent Sinus Node



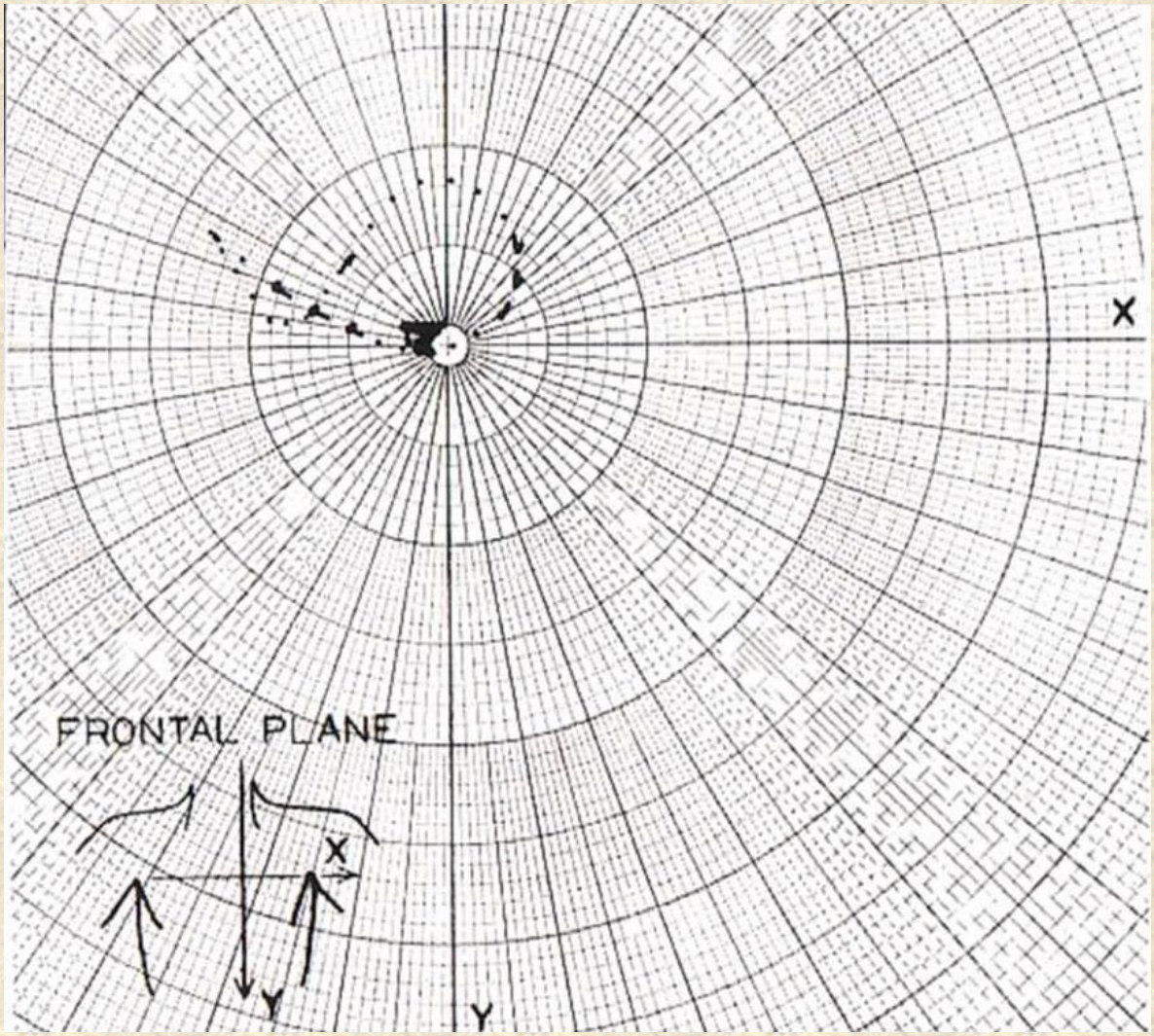
Absent Sinus Rhyrhm



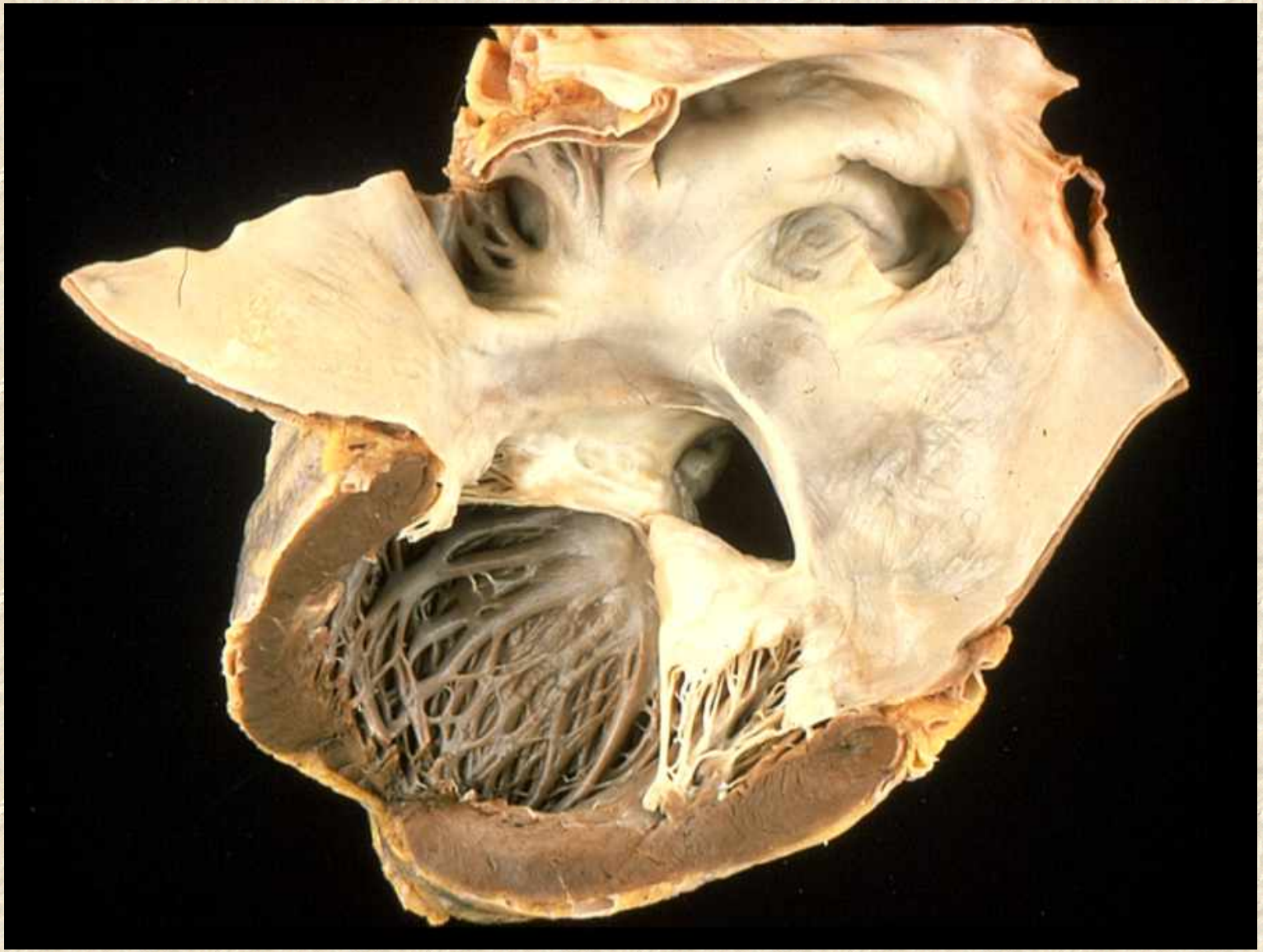
Where is the Shunt?



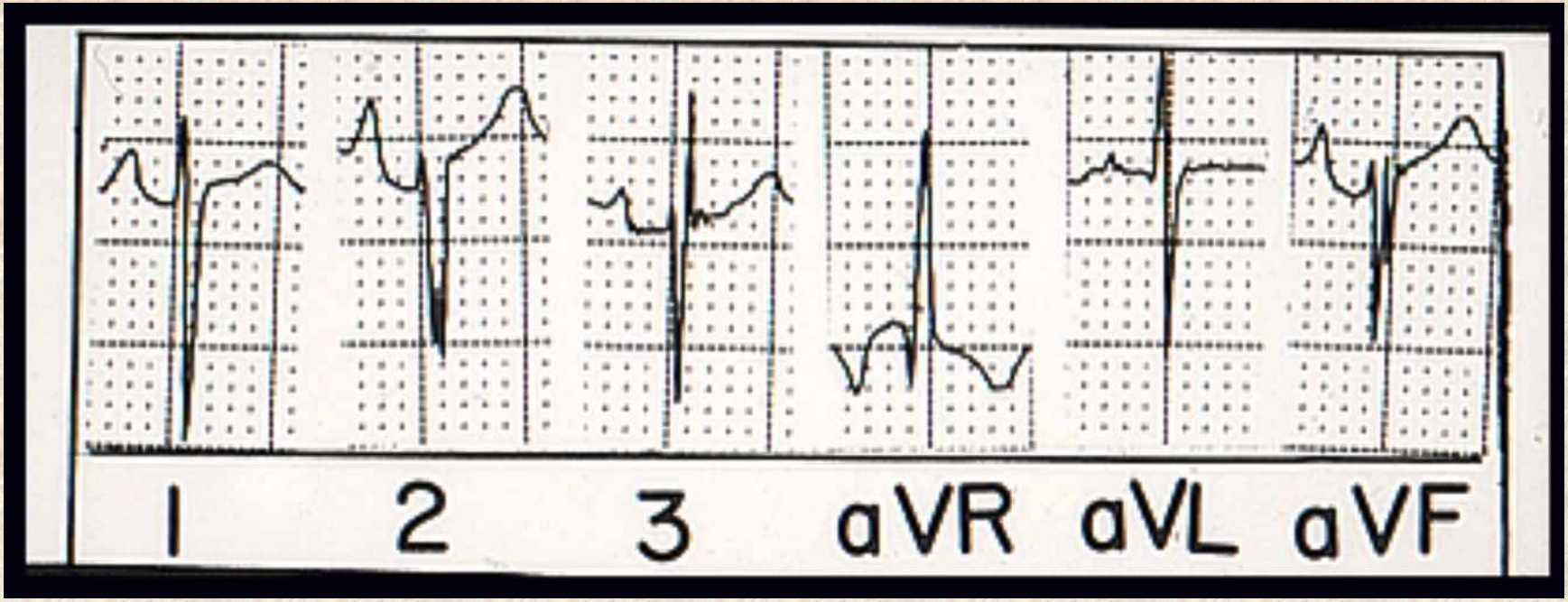
Vectorcardiogram



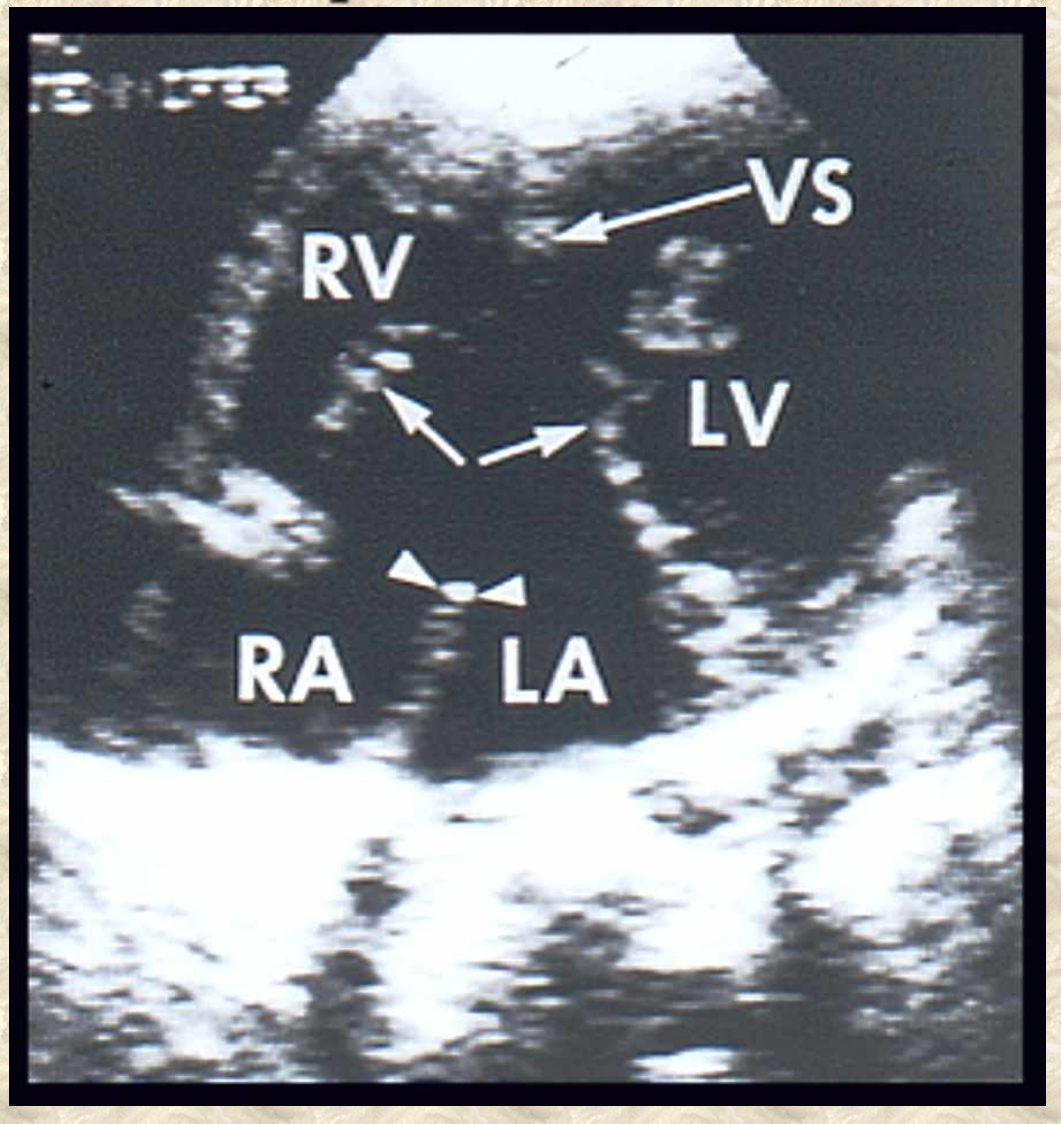
Ostium Primum ASD



Extreme Left Axis Deviation

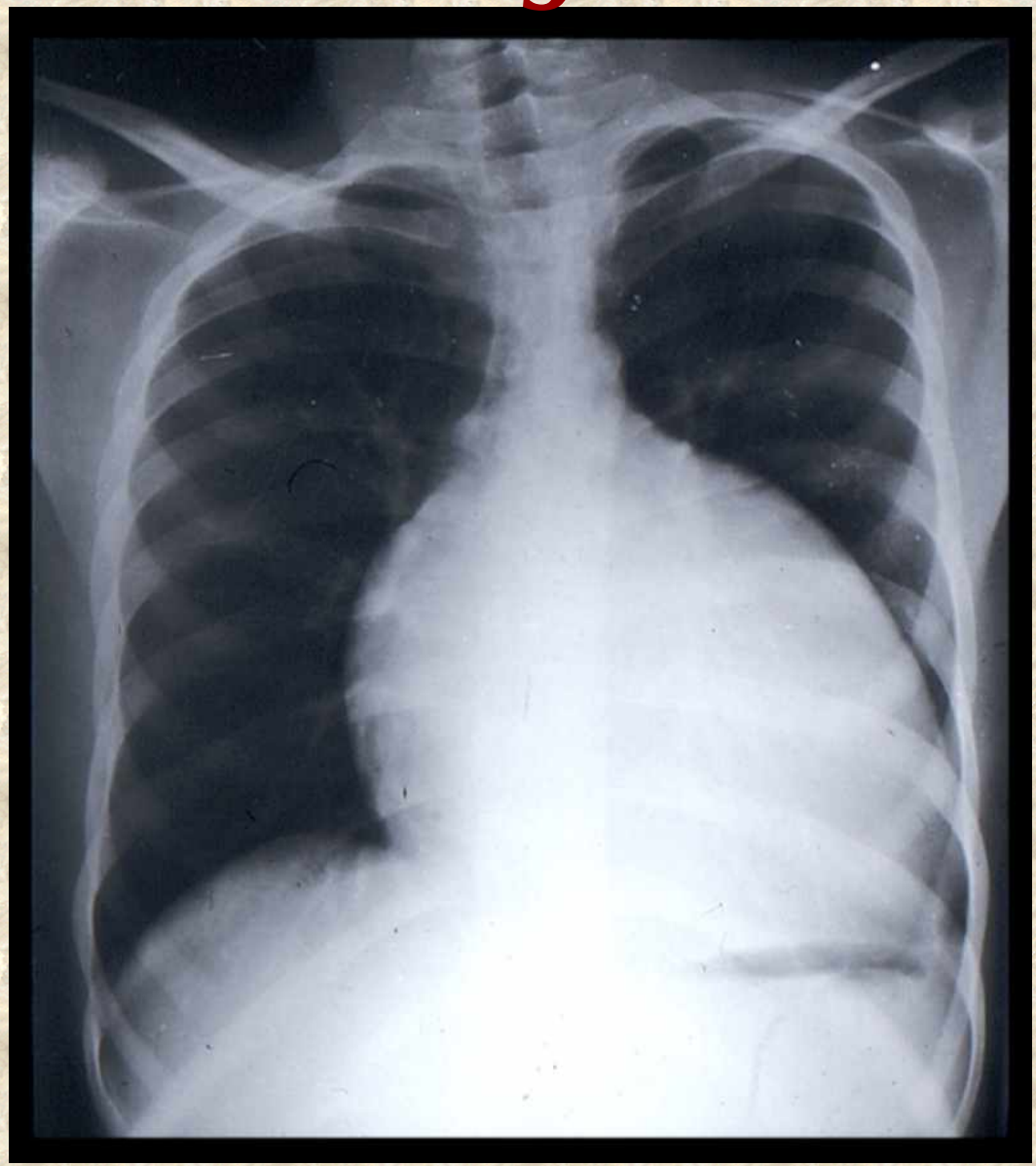


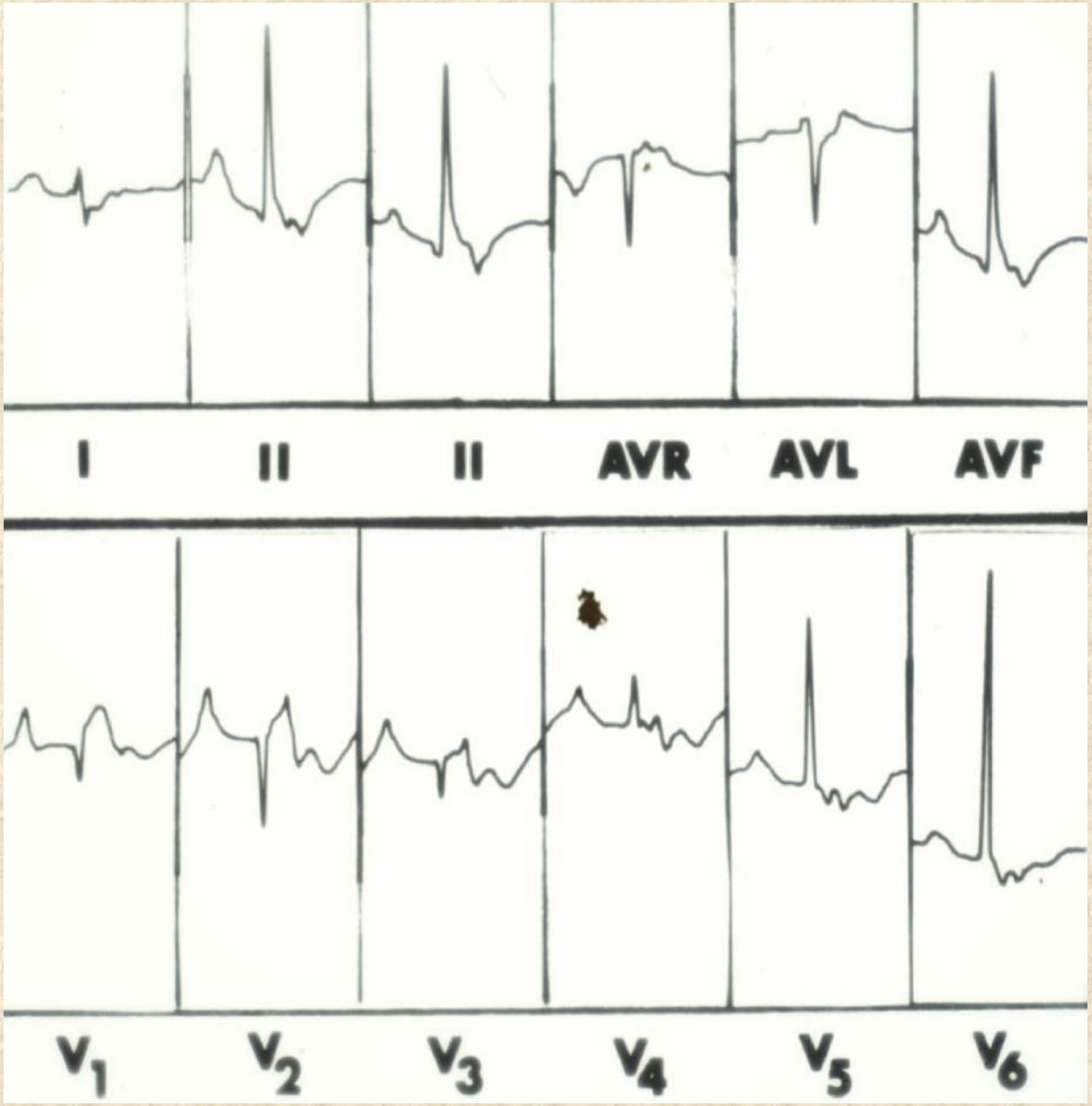
AV Septal Defect



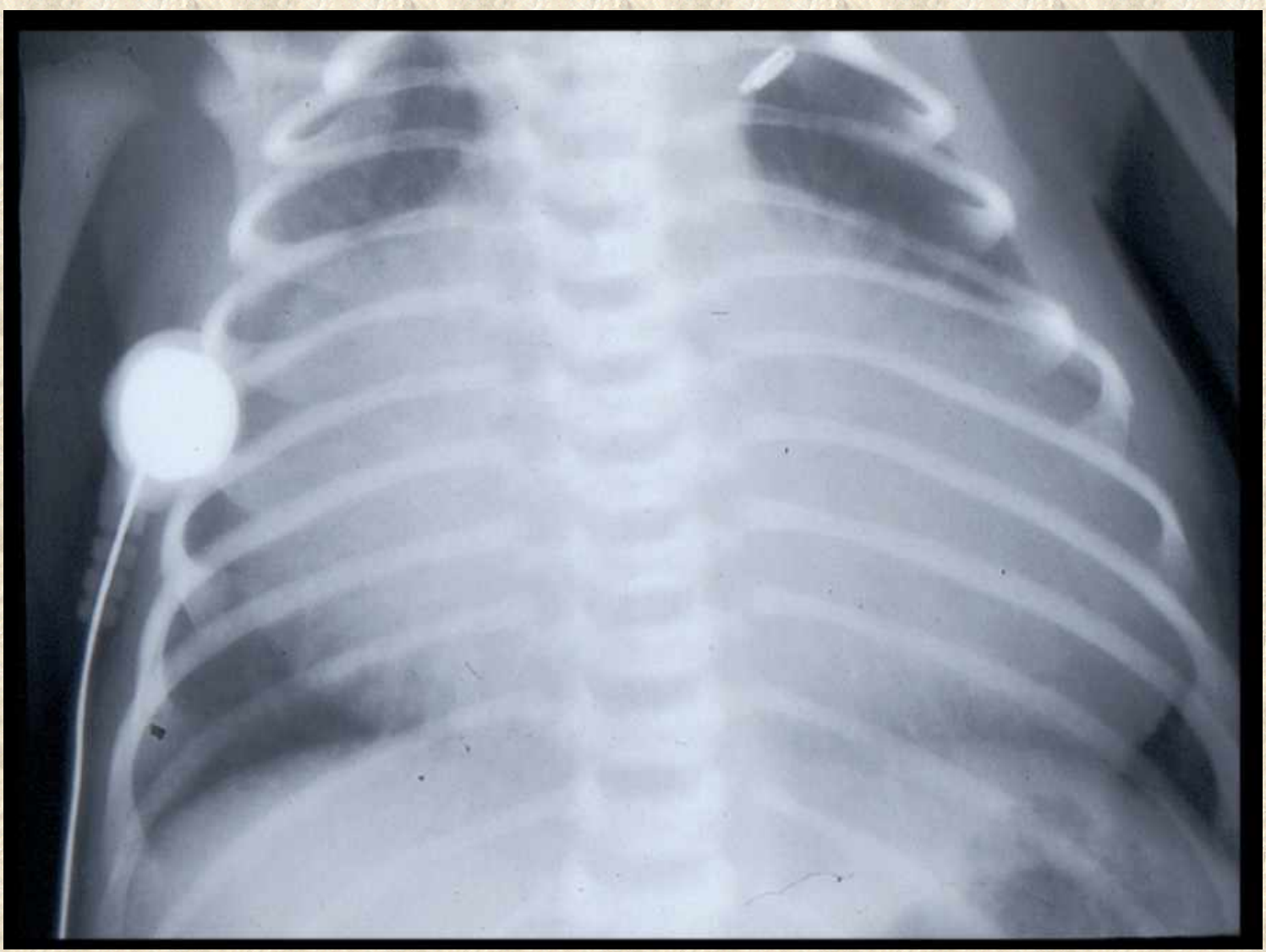
The Atria

Big

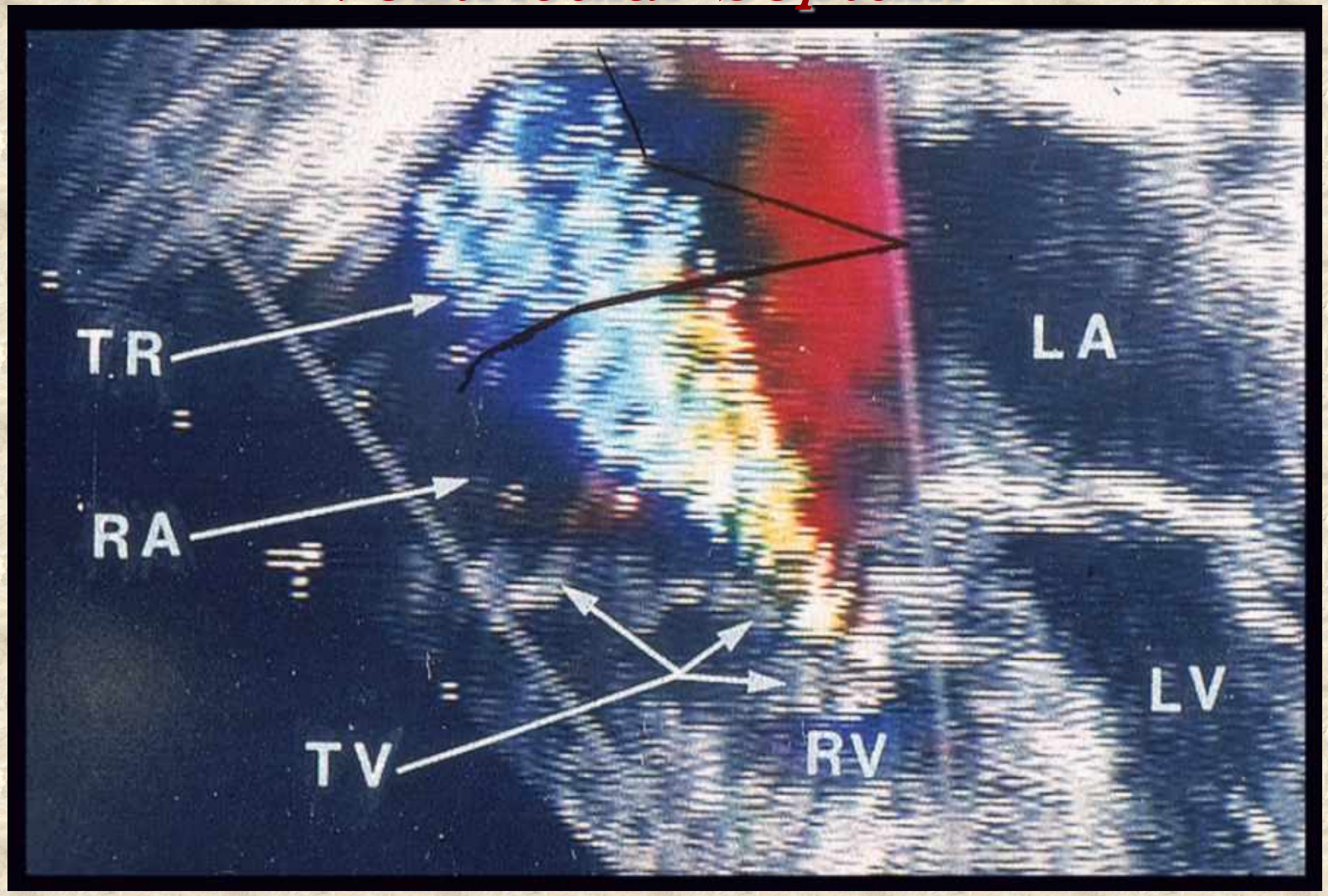



I
II
II
AVR
AVL
AVF
V1
V2
V3
V4
V5
V6

Biggest



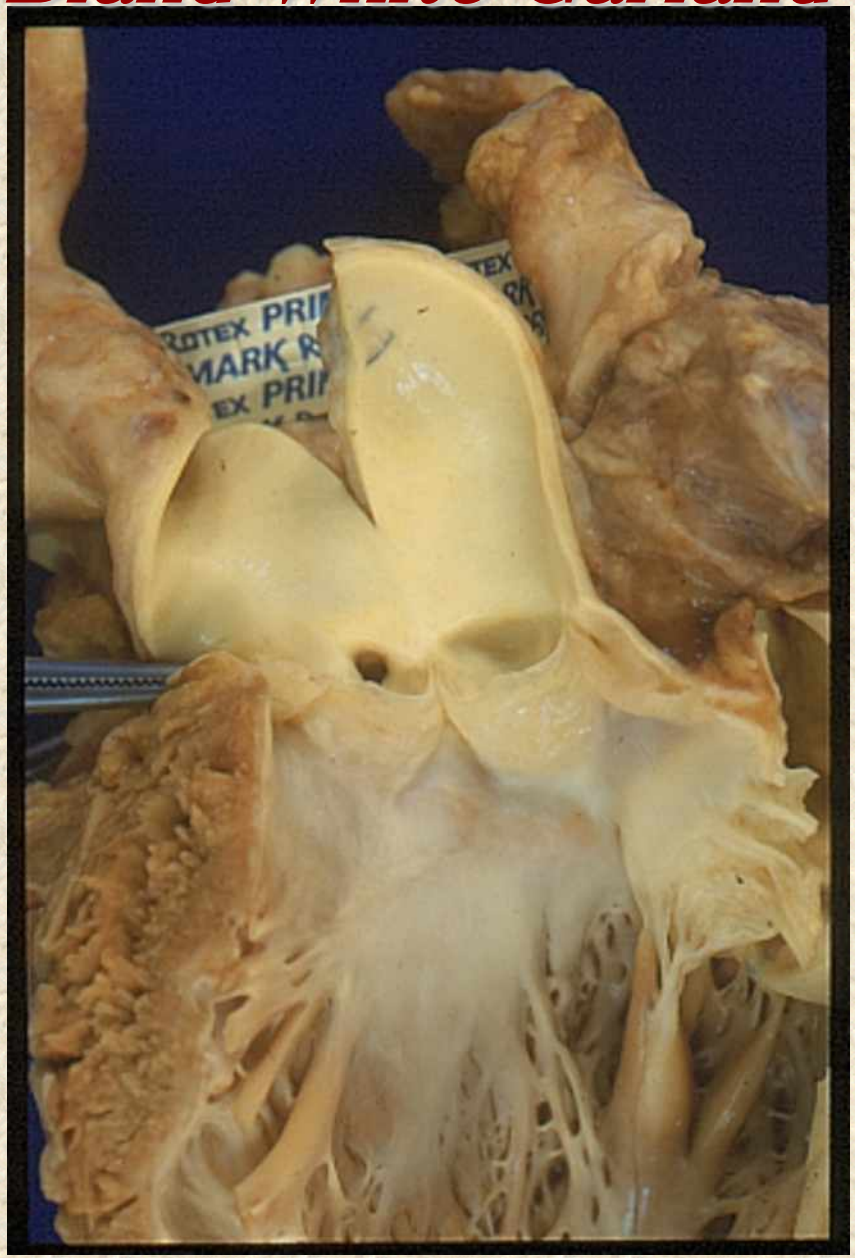
Ebstein's, Pulmonary Atresia, Intact Ventricular Septum



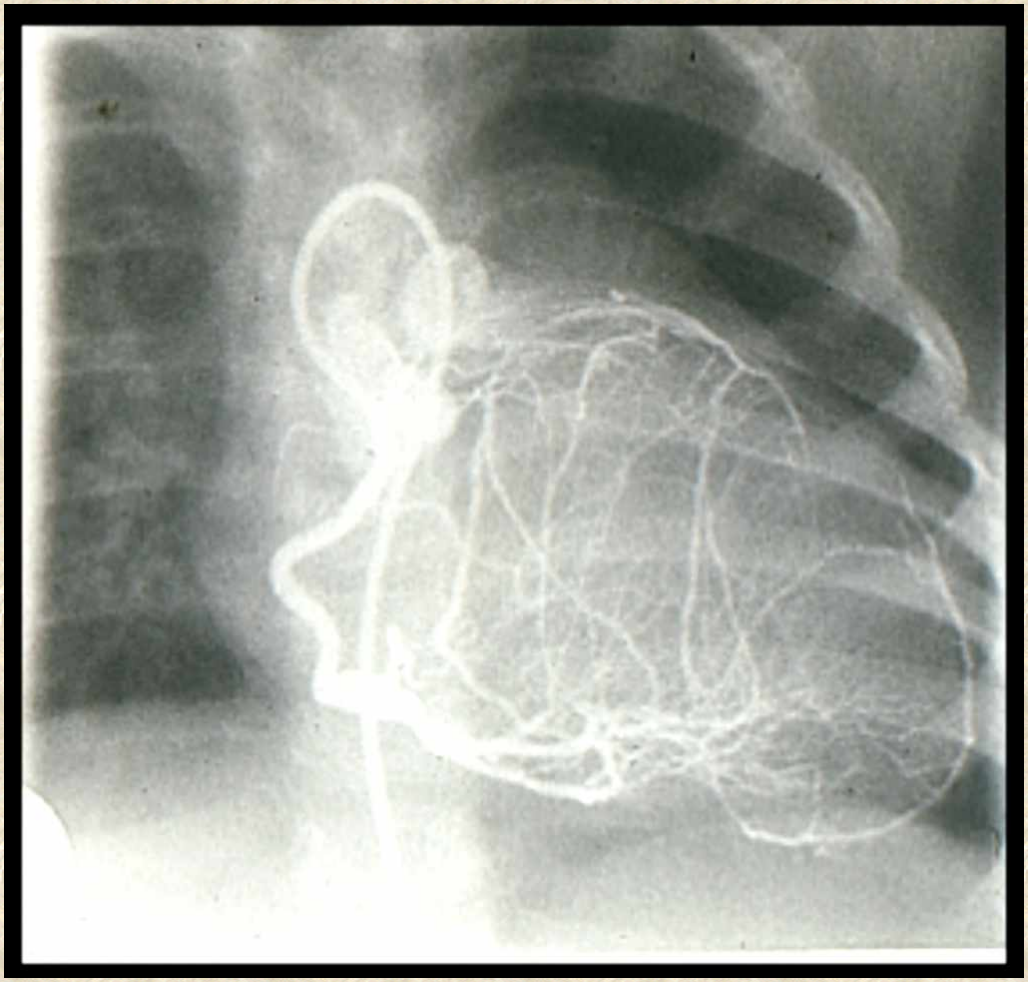
Congenital Left Axis Deviation

- Wolff-Parkinson-White type B (isolated)
- Type B WPW with Ebstein's anomaly
- Anomalous origin of LCA from pulmonary trunk
- Tricuspid atresia
- Congenitally corrected transposition
- Single ventricle (morphologic LV)
- Atrioventricular septal defect
- Double outlet right ventricle with infracristal VSD

Bland White Garland

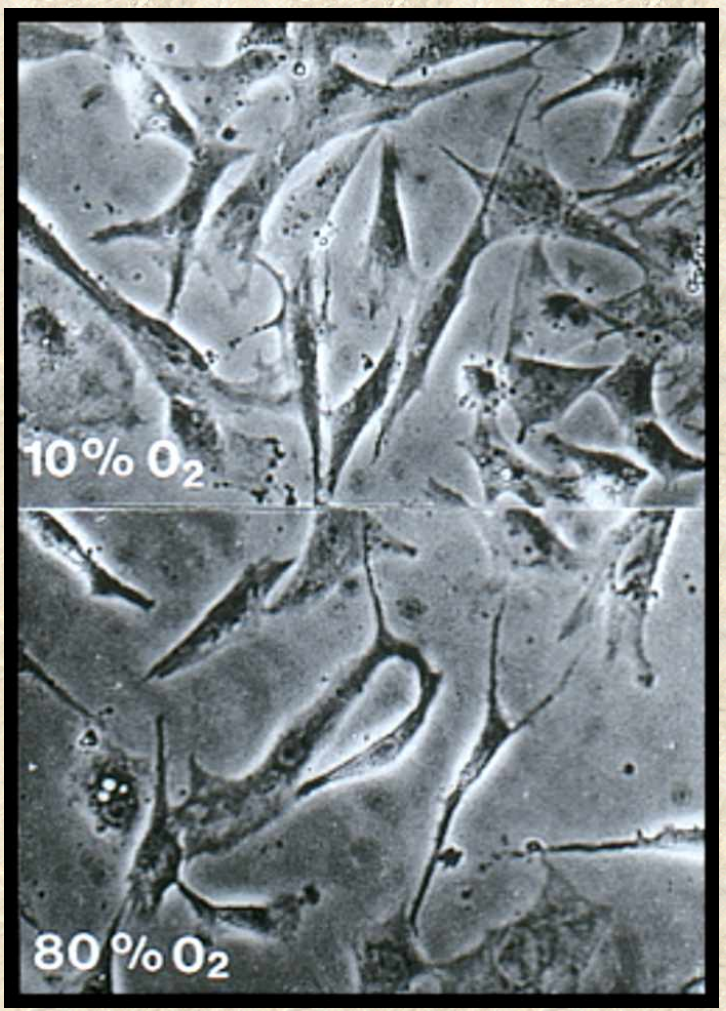


Left Coronary Artery from Pulmonary Trunk



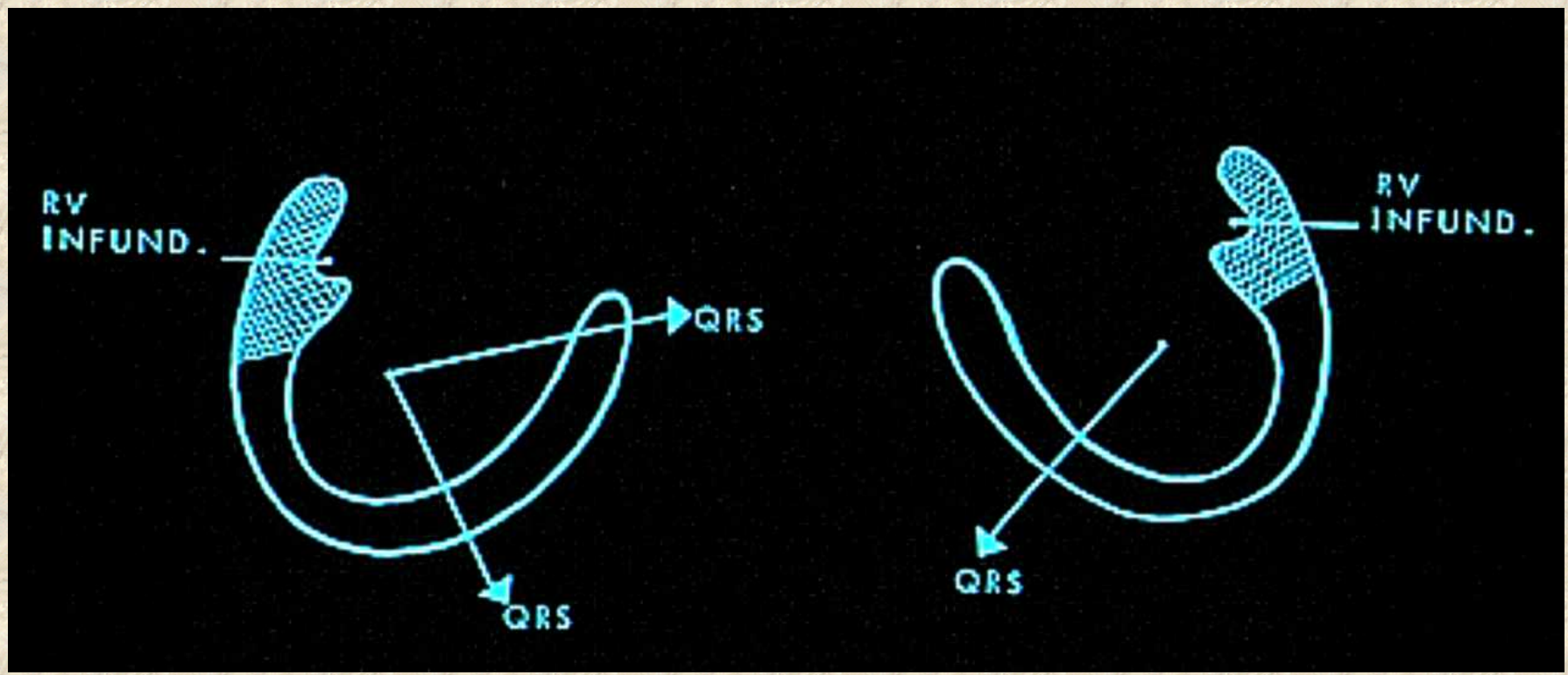
LAD, LVH, Deep Narrow Q Waves

"LVH " is Hypoxemic Hyperplasia

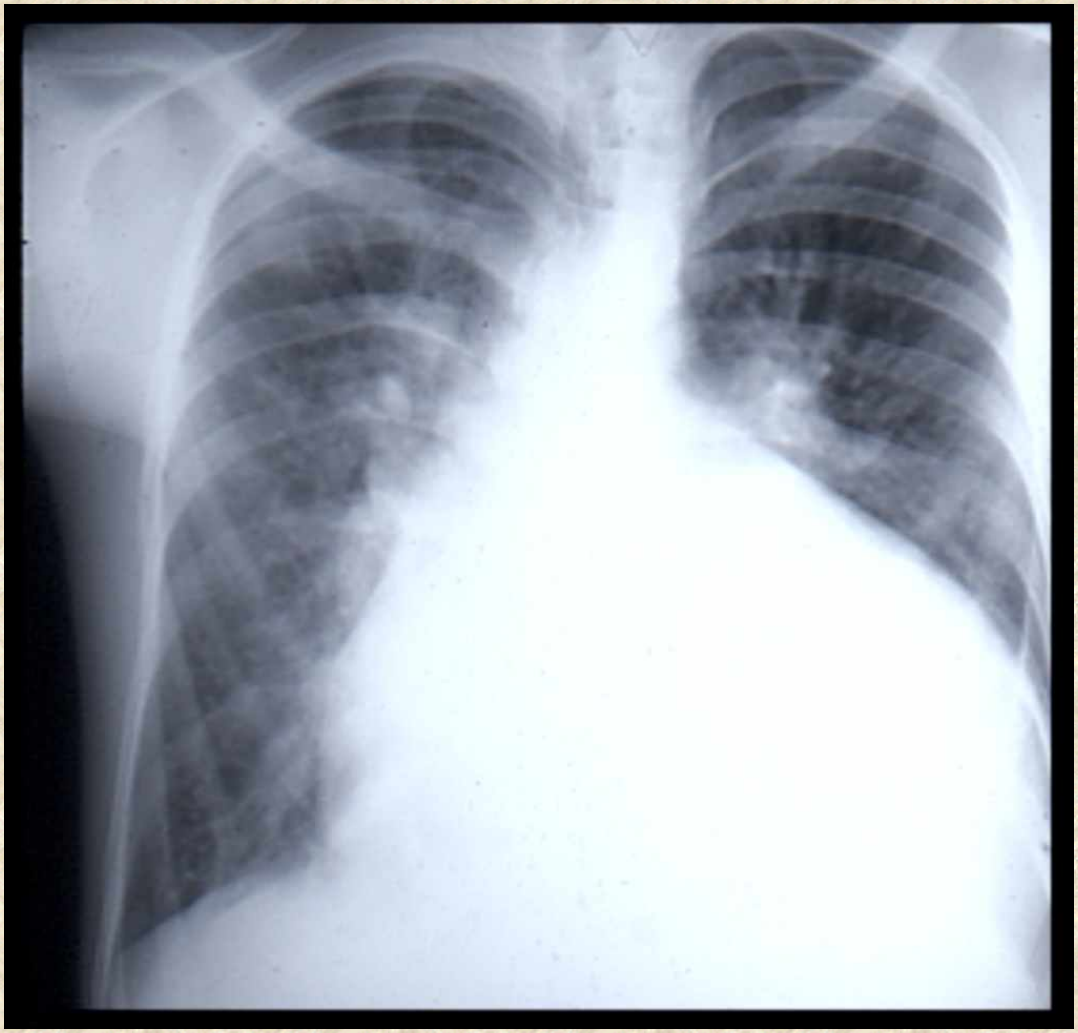


Left Axis Deviation

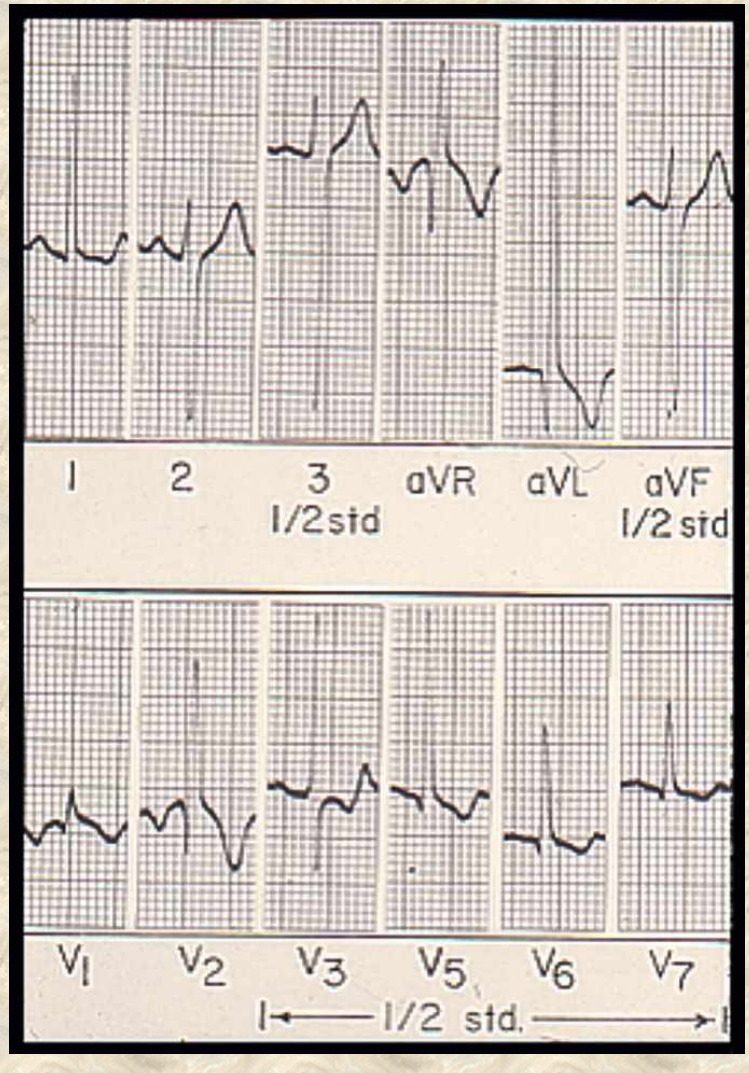
Single Ventricle, LV Morphology



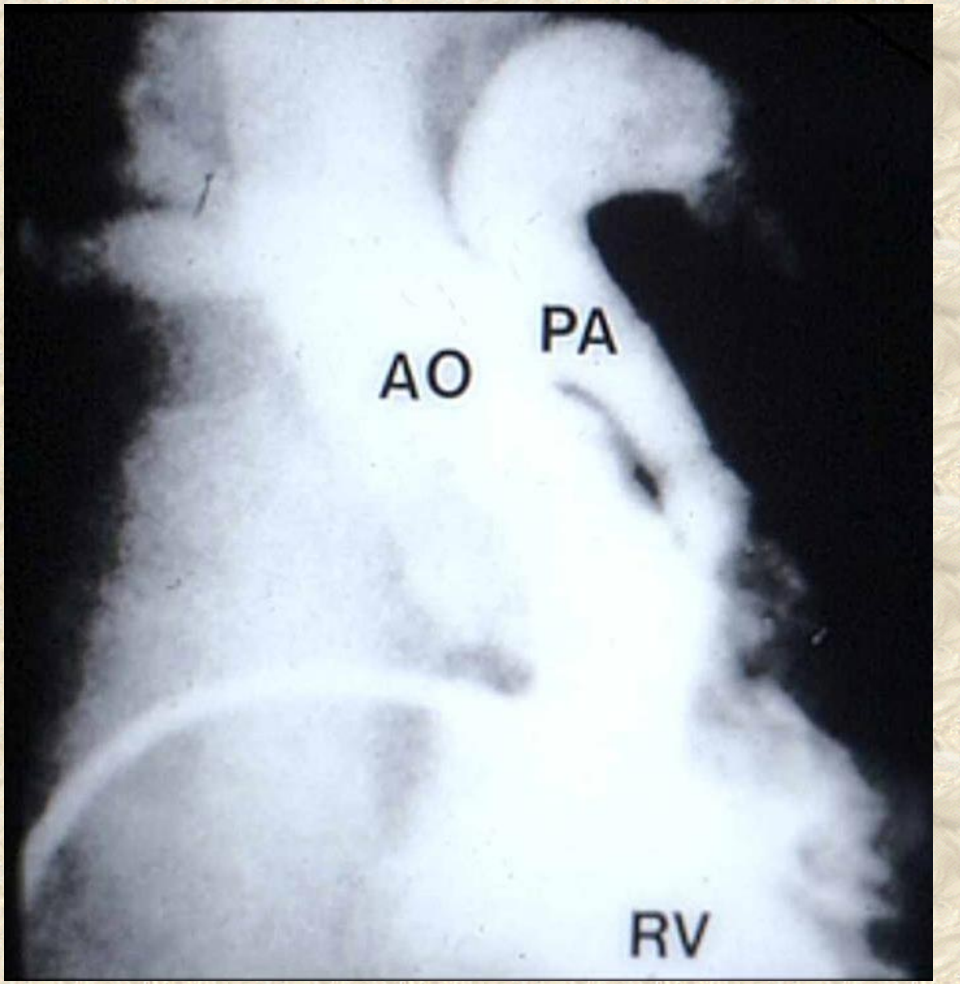
Outlet Chamber Non-Inverted



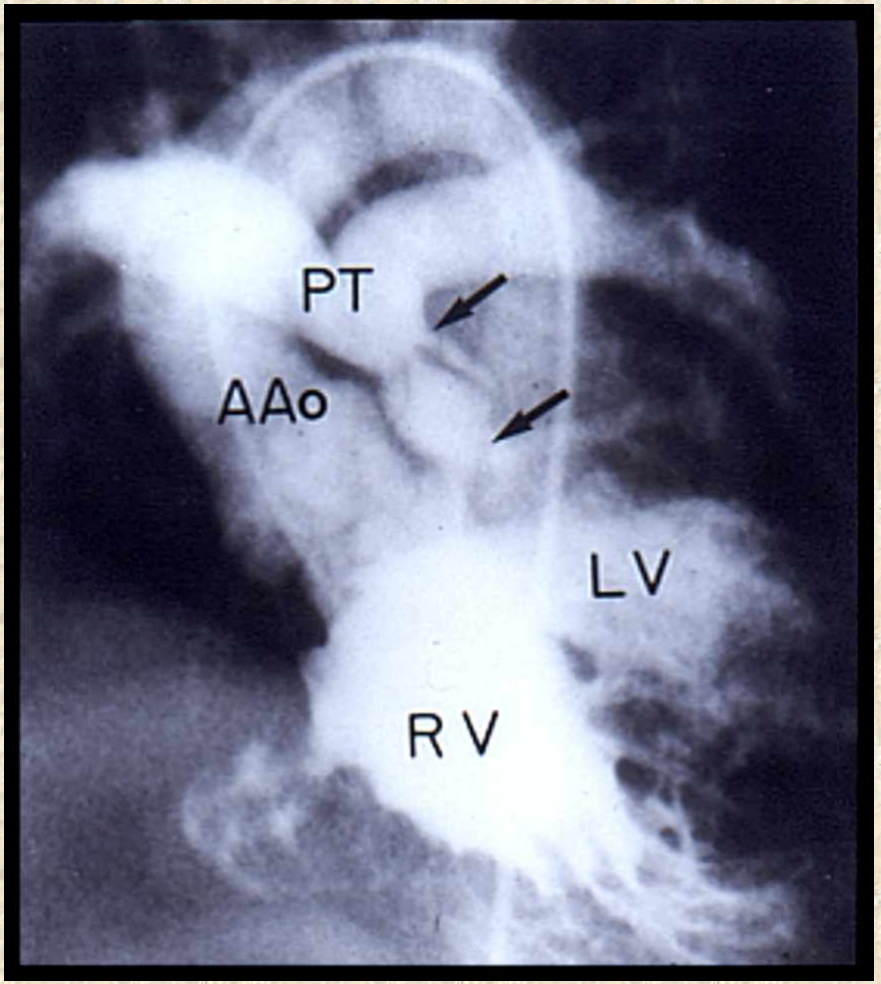
Non-Inverted Outlet Chamber ---LAD



Fallot

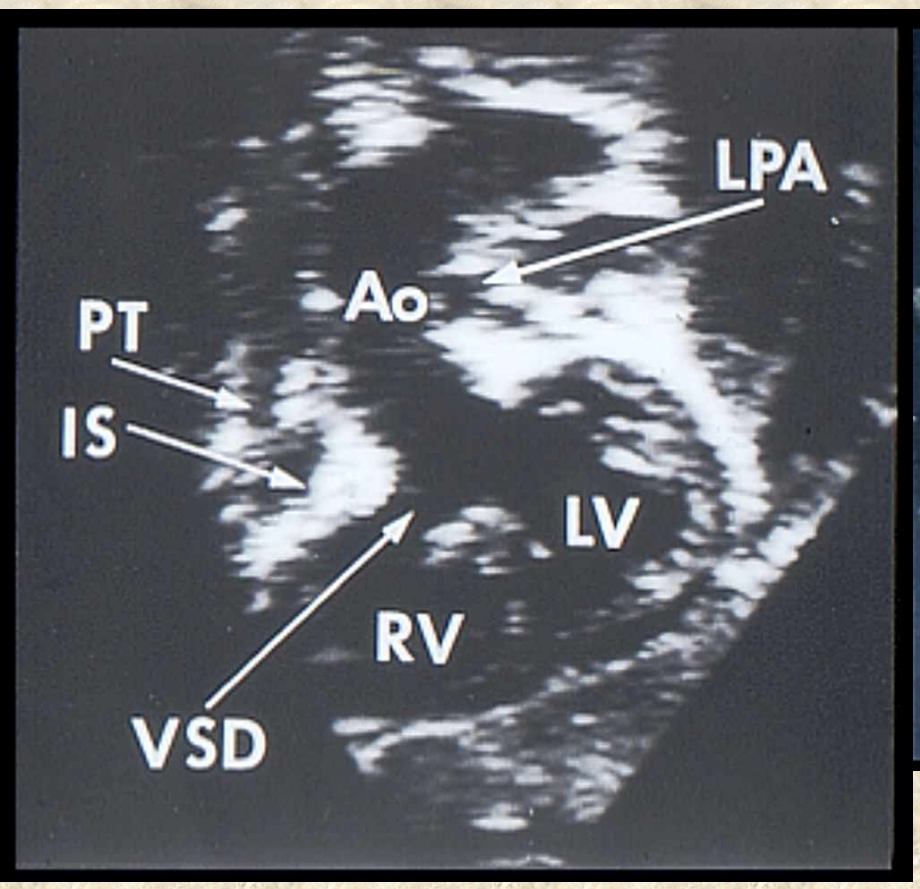


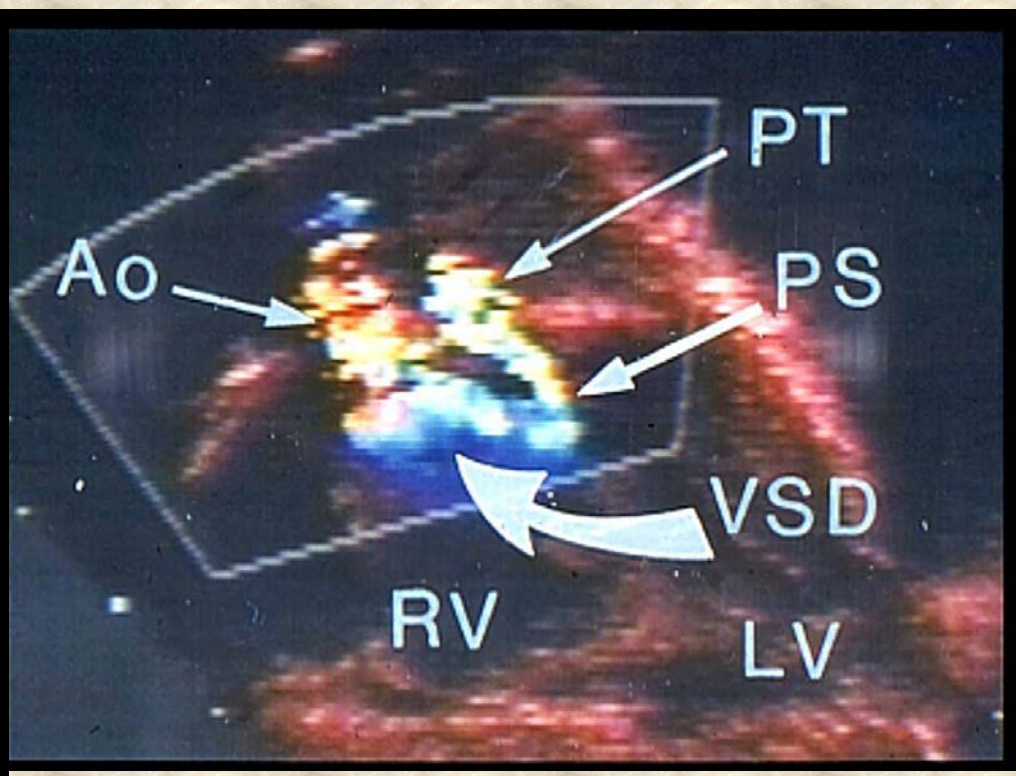
DORV PS



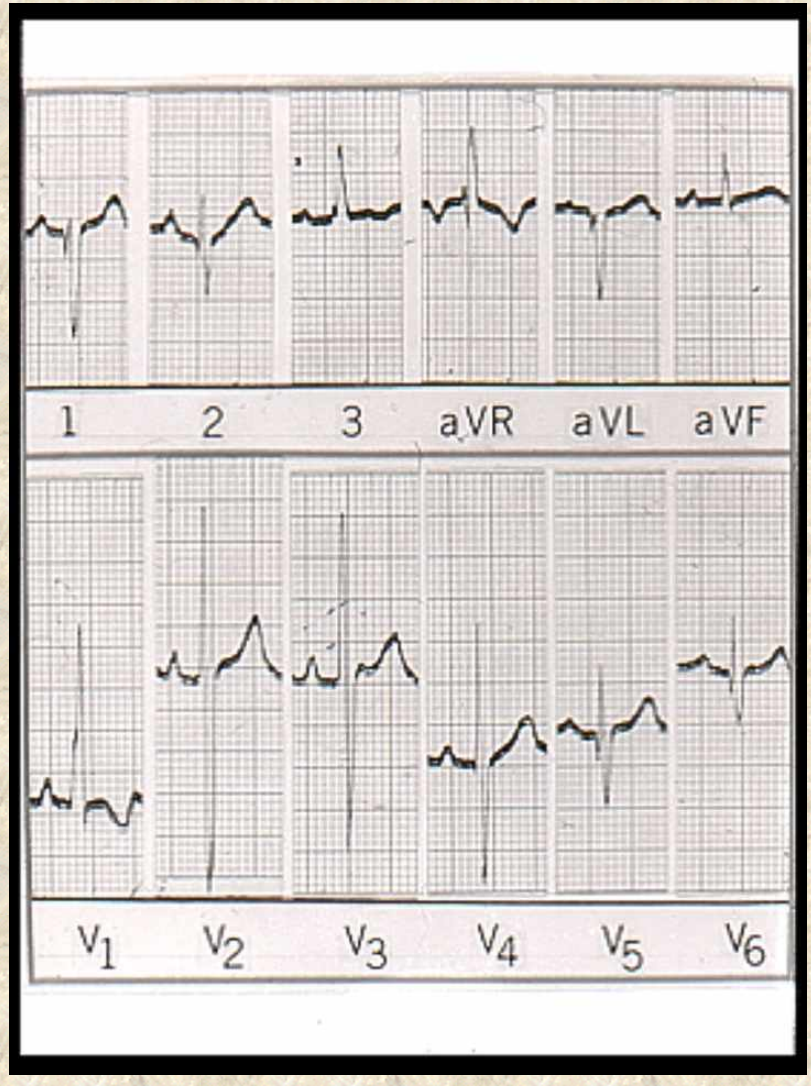
Fallot

DORV Infracristal VSD,PS



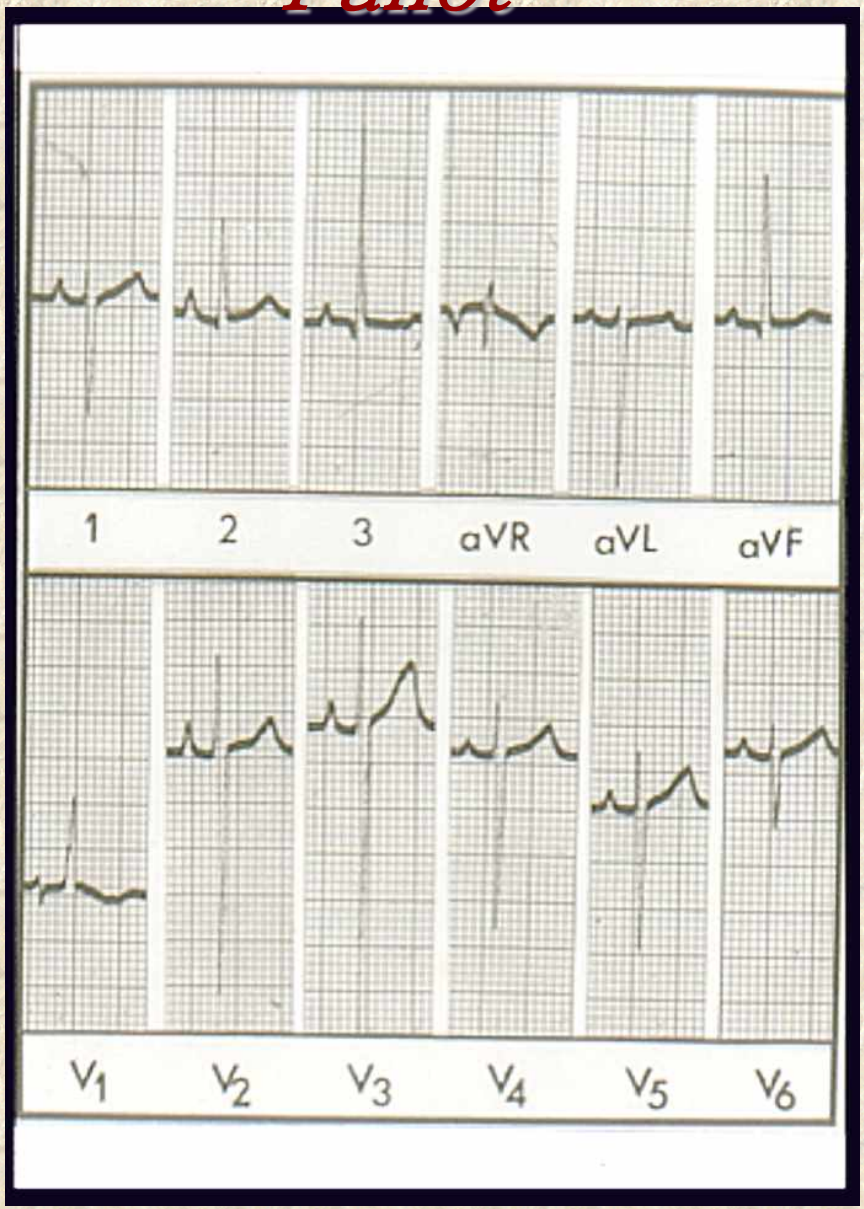


DORV PS



Initial Force Remnant of LAD

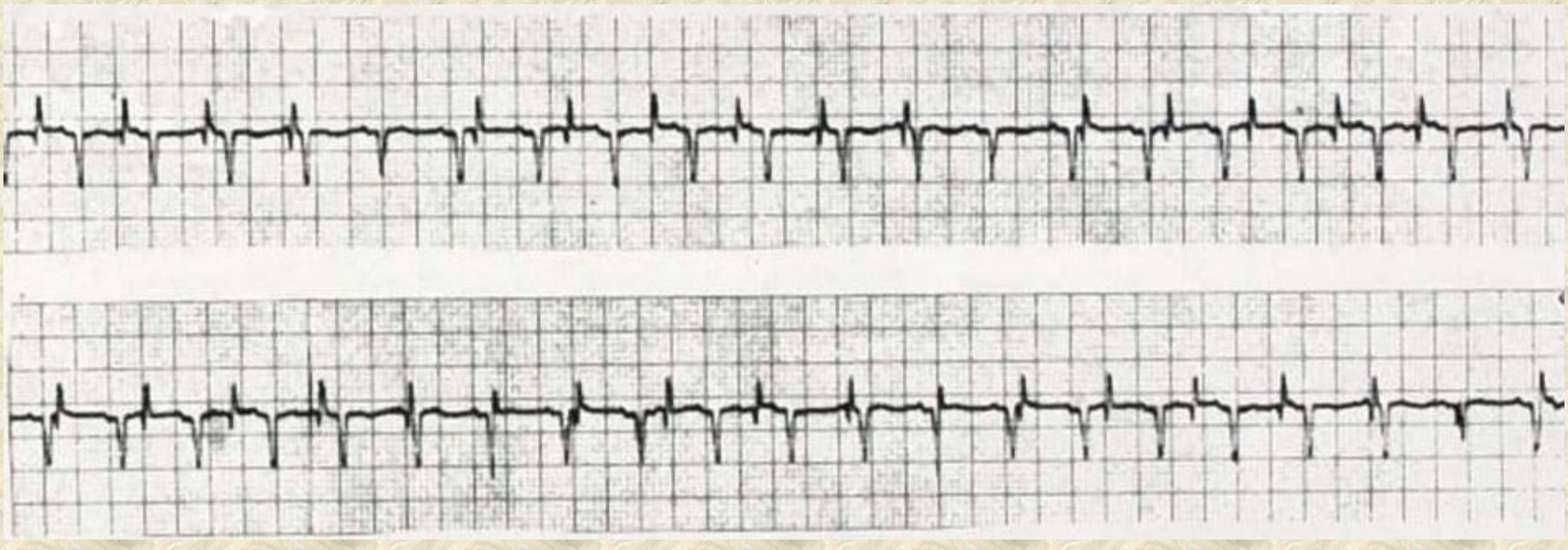
Fallot



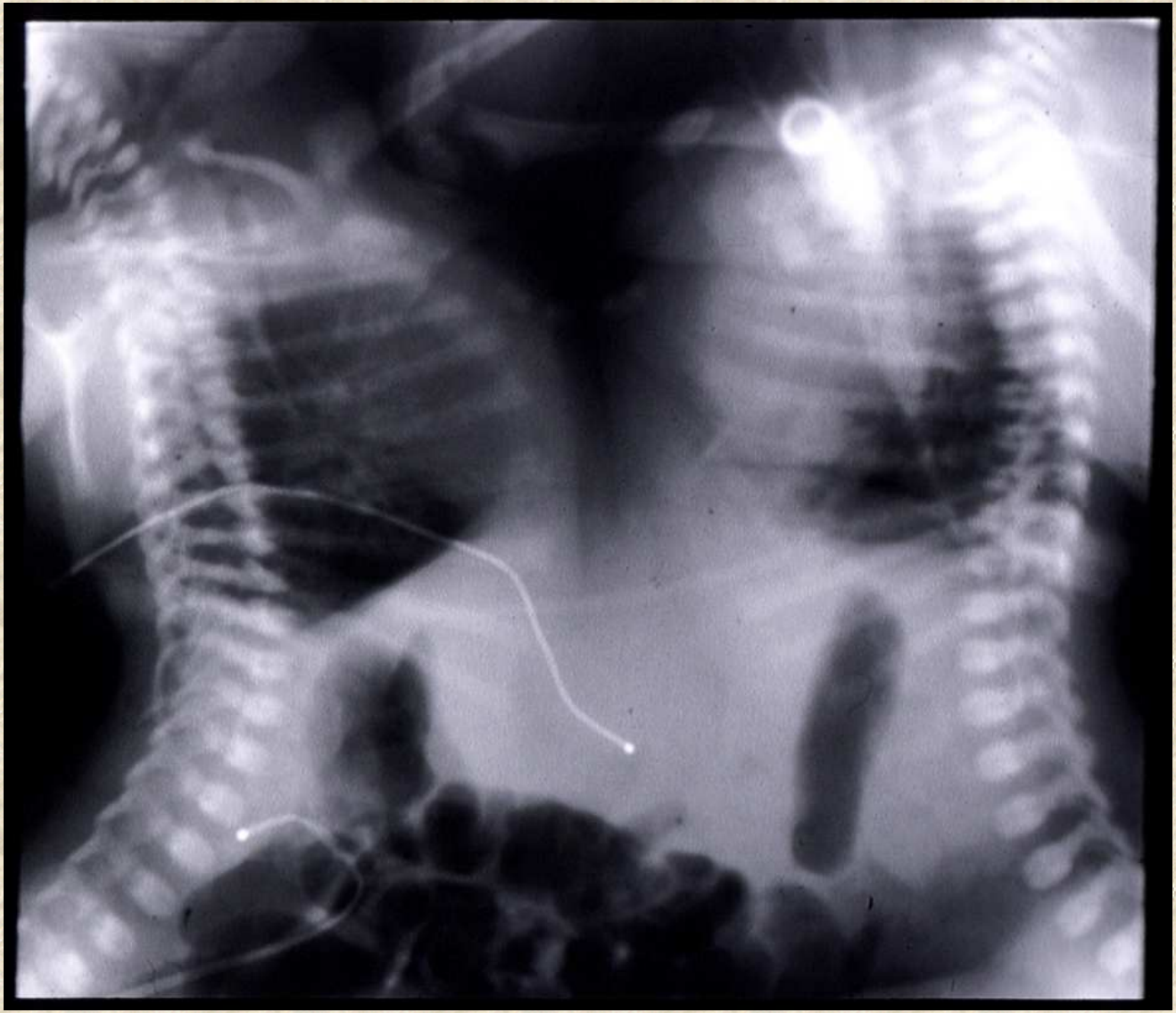
Congenital Deafness with Cardiac Arrhythmias: The Jervell and Lange-Nielsen Syndrome

A dog's Life.

Coupled Rhythms



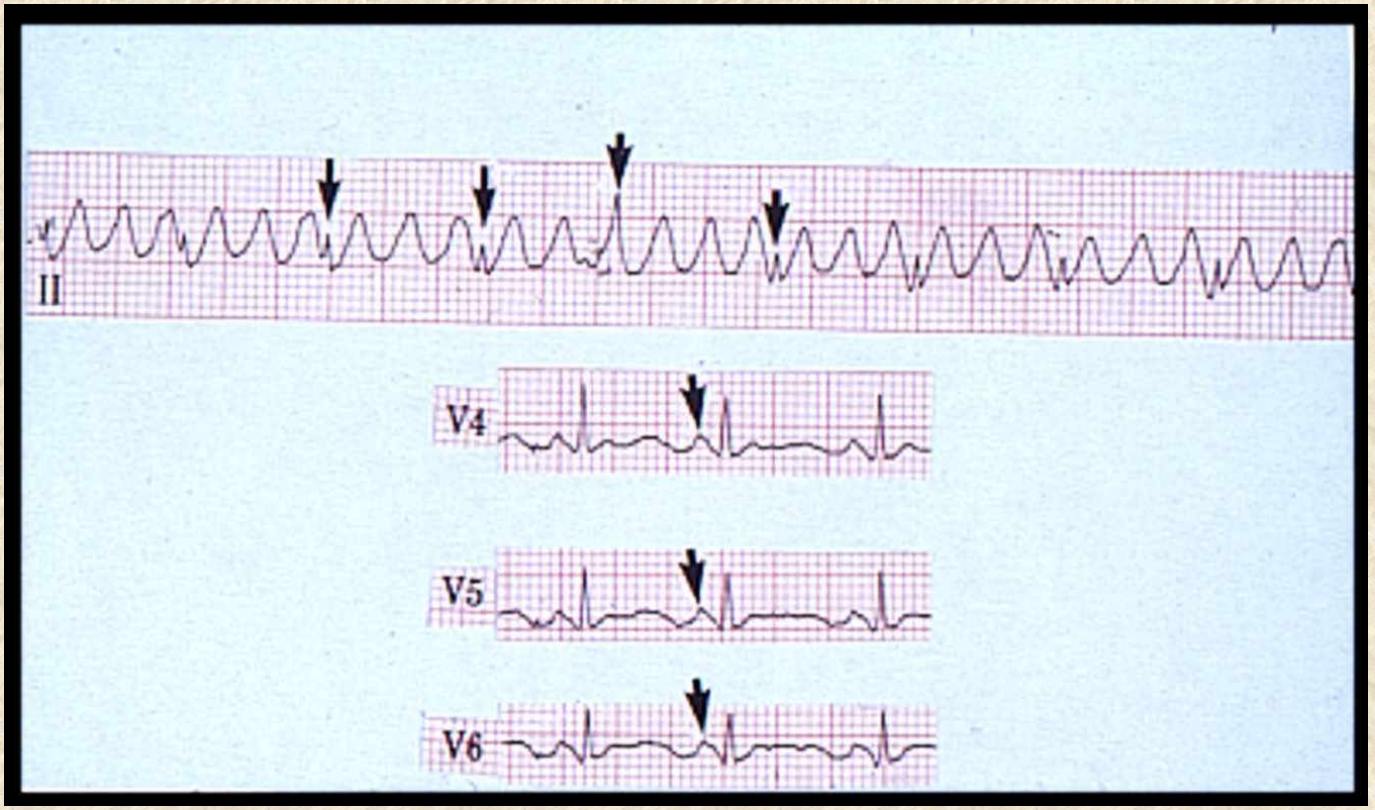
Coupled Babies



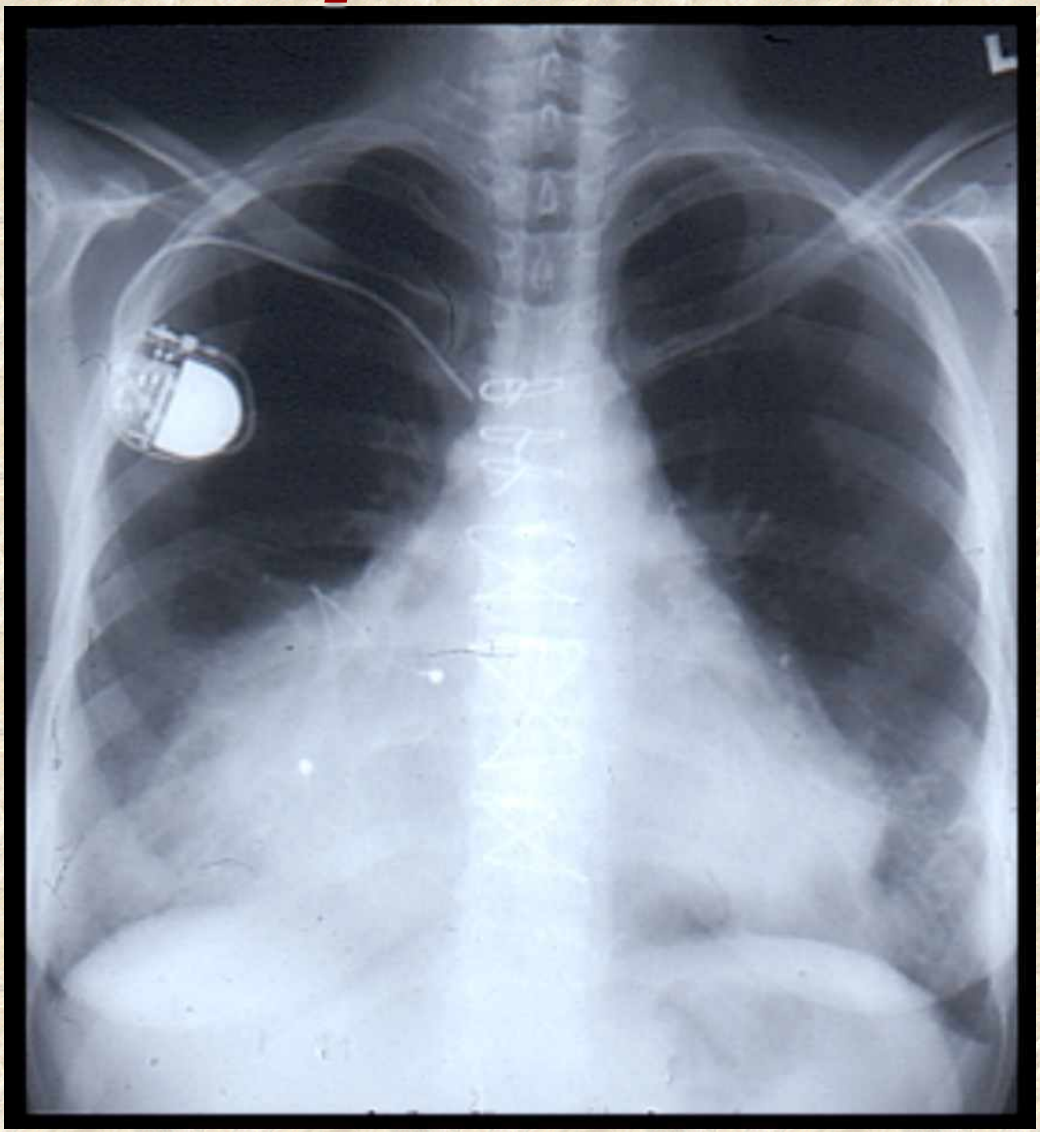
A Duet

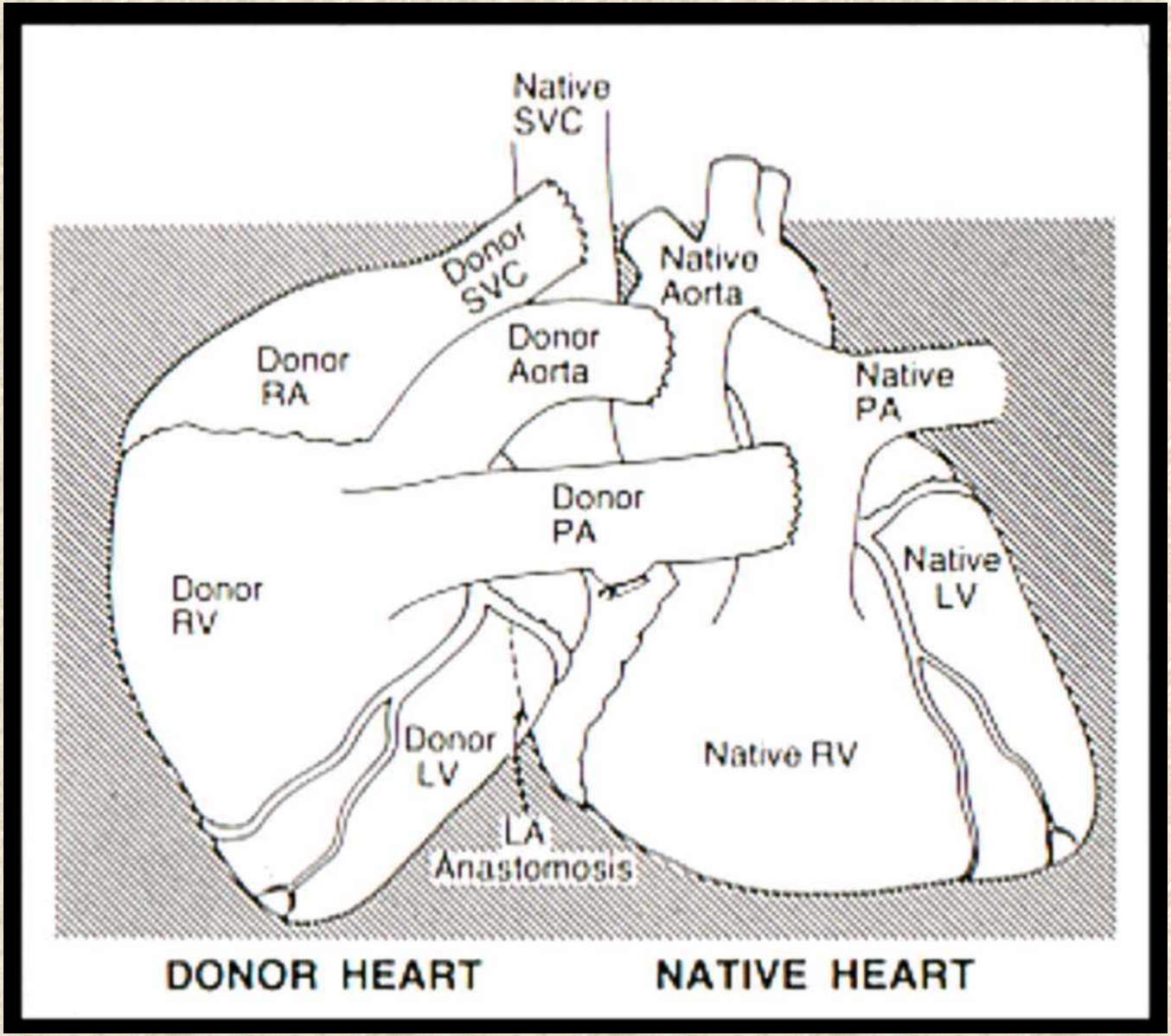
Played by two hearts beating as one.

Coupled Rhythms



Coupled Hearts




Native SVC
Donor SVC
Native Aorta
Donor Aorta
Donor RA
Native PA
Donor PA
Native LV
Donor RV
Donor LV
Native RV
LA Anastomosis
DONOR HEART
NATIVE HEART

Time Has A Way of Assigning Value

The chest X-ray and scalar ECG remain invaluable cornerstones in the clinical appraisal of congenital heart disease.

The are not precision guesswork.

They are here to stay.

The Xray and Electrocardiogram

Fiscal Rationale

Relative Costs:

1) PA/Lateral Chest X-ray -- $191.00

2) Electrocardiogram -- $172.49

---

3) Echocardiogram -- $1,647

4) Cardiac MRI -- $2,431

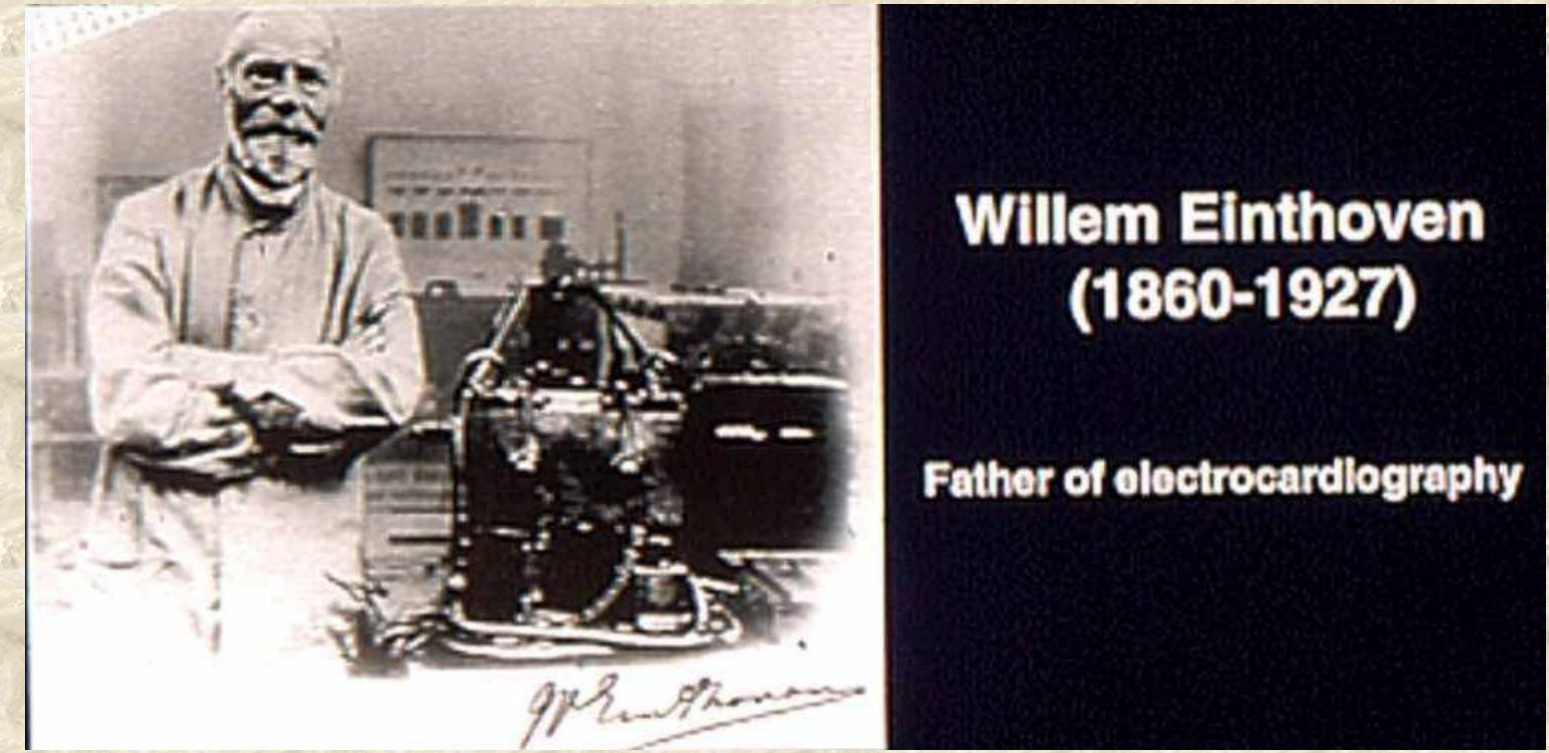
5) Right/Left cardiac catheterization -- $8,000

Thank You

I shall focus on two aspects of this topic:

1) Unusual or atypical arrhythmias.

2) The signal averaged electrocardiogram



Einthoven W. Uber die form des menschlichen neurosurg. Pflugers Arch 1895

The Electrocardiogram

Many brilliant minds have contributed to the development of electrocardiography as a clinical science. The early history (1900-1945) was dominated by Professor Willem Einthoven in the Netherlands, Sir Thomas Lewis in England and Dr. Frank N. Wilson in the United States. These three pioneers laid the foundation for modern electrocardiography.

Charles Fisch, The ECG Centennial

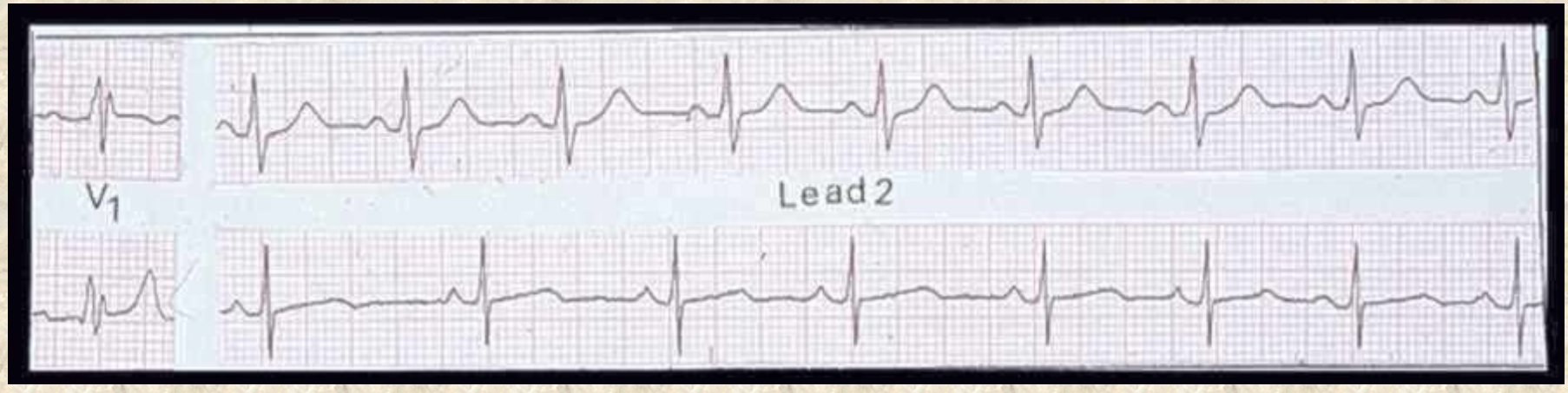
Sinus arrhythmia in children with atrial septal defect: An analysis of heart rate variability before and after surgical repair

Finley JP, et al. Br Heart J 1989

Sinus arrhythmia in children with atrial septal defect: An analysis of heart rate variability before and after surgical repair

Finley JP, et al. Br Heart J 1989

Secundum ASD
Before and After Closure



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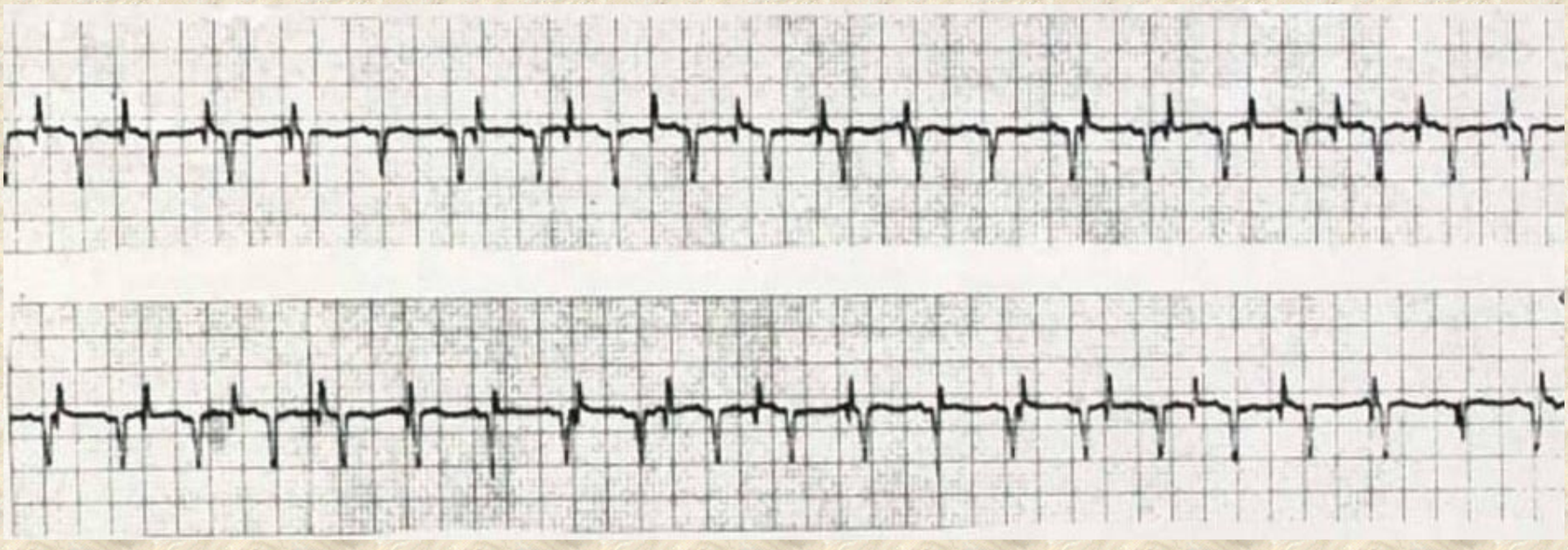
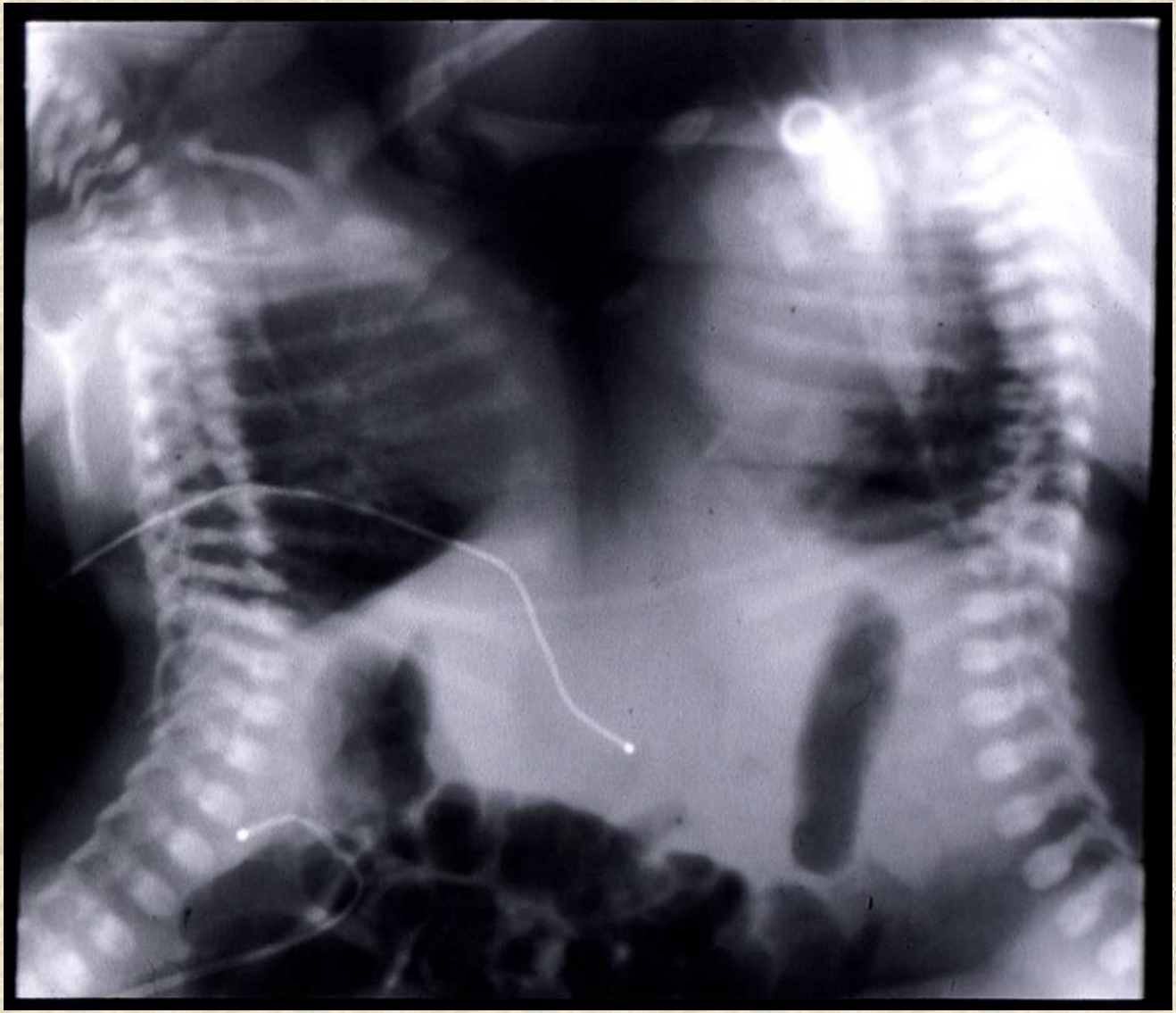


Coupled Babies



Background and Rationale

In the 1970's, Michael B. Simson at the University of Pennsylvania,developed the signa averaged ECG to identify the slow conduction substrates of reentry. arrhythmogenic substrate usually to the ventriculotomy scar where

970's, Michael B. Simson at the Ur
vania, developed the signal averag
slow conduction substrates of ree
perative arrhythmogenic substrate
the ventriculotomy scar where it
d and eliminated by radiofrequency
al advances permit confident inter
CG's despite post-ventriculotomy

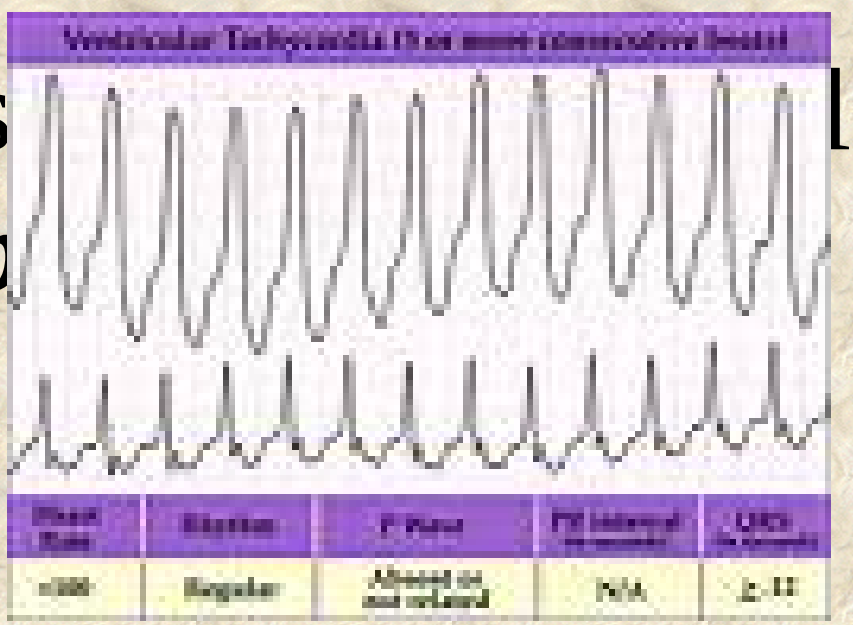
The Signal Averaged Elecrocardiogram for Detection of Post-ventriculotomy Late Potentials of Reentrant Monomorphic Ventricular Tachycardia

A Step in the Right Direction ?

Ventricular Tachycardias

Electrophysiologic mechanisms of vent
include ***reentry, automaticity, and trigg***

Inducible s lar tachycar
monomorp

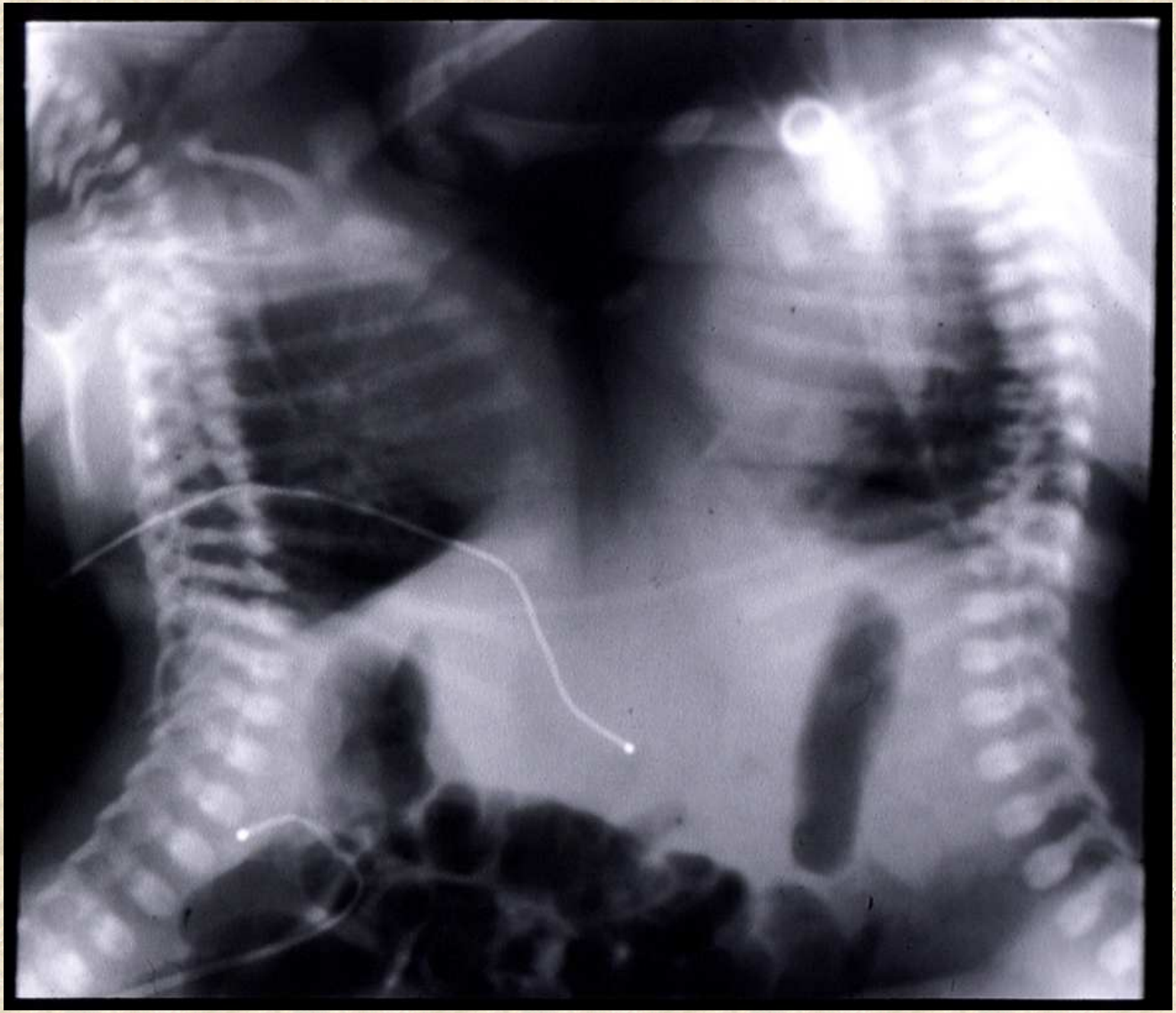


Basis for the Judgment & Recommendations in this Report

A prospective study that extended from J
included 242 consecutive patients in who
after---and often before and after---right
repair of CHD.

Perloff JK, Middlekauf HR, Stevenson WG, et al.
Usefulness of Post-ventriculotomy Signal Averaged Electrocardiograms in Congenital Heart Diseae.
Am J Cardiol 2006;98:1646-1651

Coupled Babies

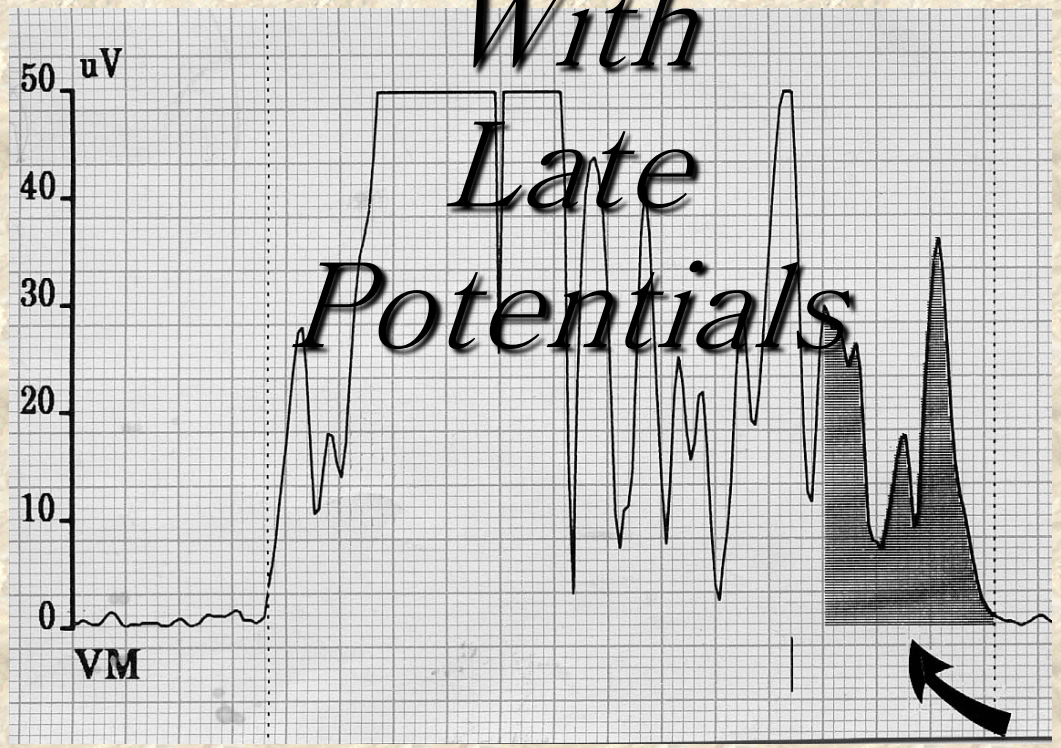


Definition & Implications

A positive SAECG is defined as a fi
duration >145 msec plus root mean squa
of the terminal 40 msec of the filtered Q
microvolts, and/or low amplitude signal
terminal filtered QRS > 50 msec.

A ***positive SAECG*** indicates the presenc

SAECG With Late Potentials



The Trigger

A slow conduction arrhythmogenic reentrant substrate remains dormant unless activated (triggered). Accordingly, the overt expression of reentrant MVT requires a susceptible substrate *and* an effective trigger. ***Severe pulmonary regurgitation*** is such a trigger.

Established Risk Factors for MVT

These factors include scalar QRS durati
increase in QRS duration ≥ 30 msec ove
pulmonary regurgitation, depressed right
function, ventricular ectopic beats induc
≥3 consecutive monomorphic ventricula
≥age at ventriculotomy, and a decade or

Importantly, patients with QRS duratio
SAECG's, and patients with QRS duratio
negative SAECG's, so the QRS duration

Intracardiac Electrophysiology

When sustained MVT is inducible in
SAECG's, the commonest site of the sl
substrate is along the ventriculotomy sc

The Best Results

Substrates can be localized by mapp
by radiofrequency ablation.