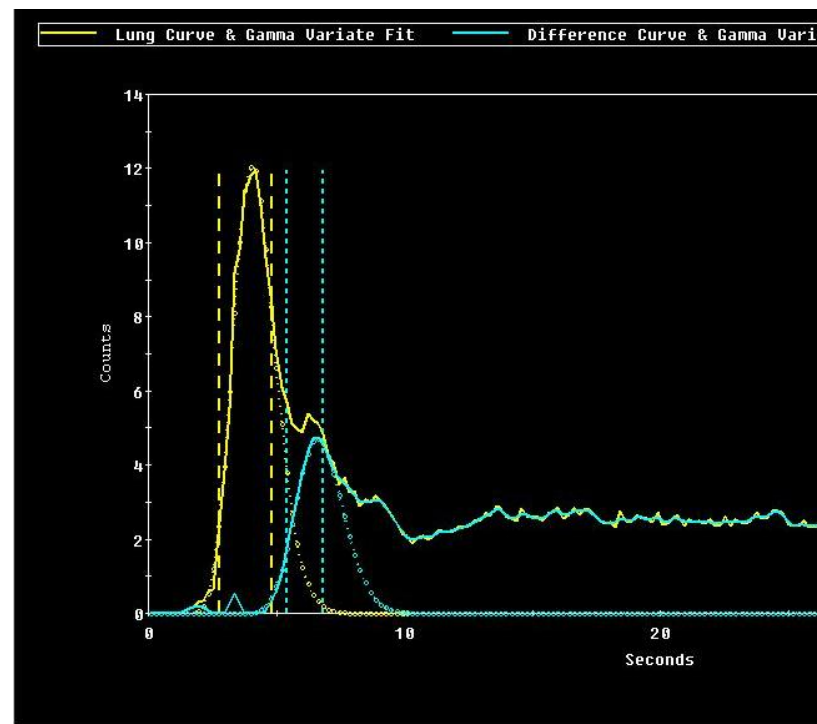


FIRST PASS RADIONUCLIDE ANGIOCARDIOGRAPHY



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- diagnostic imaging method which uses intravenously injected radiopharmaceutical for dynamic scintigraphy of the first pass of radiopharmaceutical through the heart, lungs and blood vessels by gamma camera over the heart
- analysis of sequential scintigraphs and generating “time activity curve” allows for diagnosis of heart abnormalities with pathologic communication between heart chambers or between pulmonary artery and aorta, and for quantification of left-to-right and right-to-left shunts

Radiopharmaceuticals and biodistribution

- Tc-99m-pertechnetate or Tc-99m labeled albumin or red blood cells
- 8-10 mCi/m², adults 20 mCi; minimal dose 2 mCi, volume < 0,5 ml, bolus injection flushed with 10 ml saline
- v. jugularis interna or v. jugularis externa

- Supine position, gamma camera precordial
- collimator: multihole parallel, high sensitivity or convergating
- 2-20 frame/sec (1 frame: 0,05-0,5 sec) = better time resolution, during 30 sec
- Images are stored to a computer
- Premedication with Na-perchlorate (Irrenat)

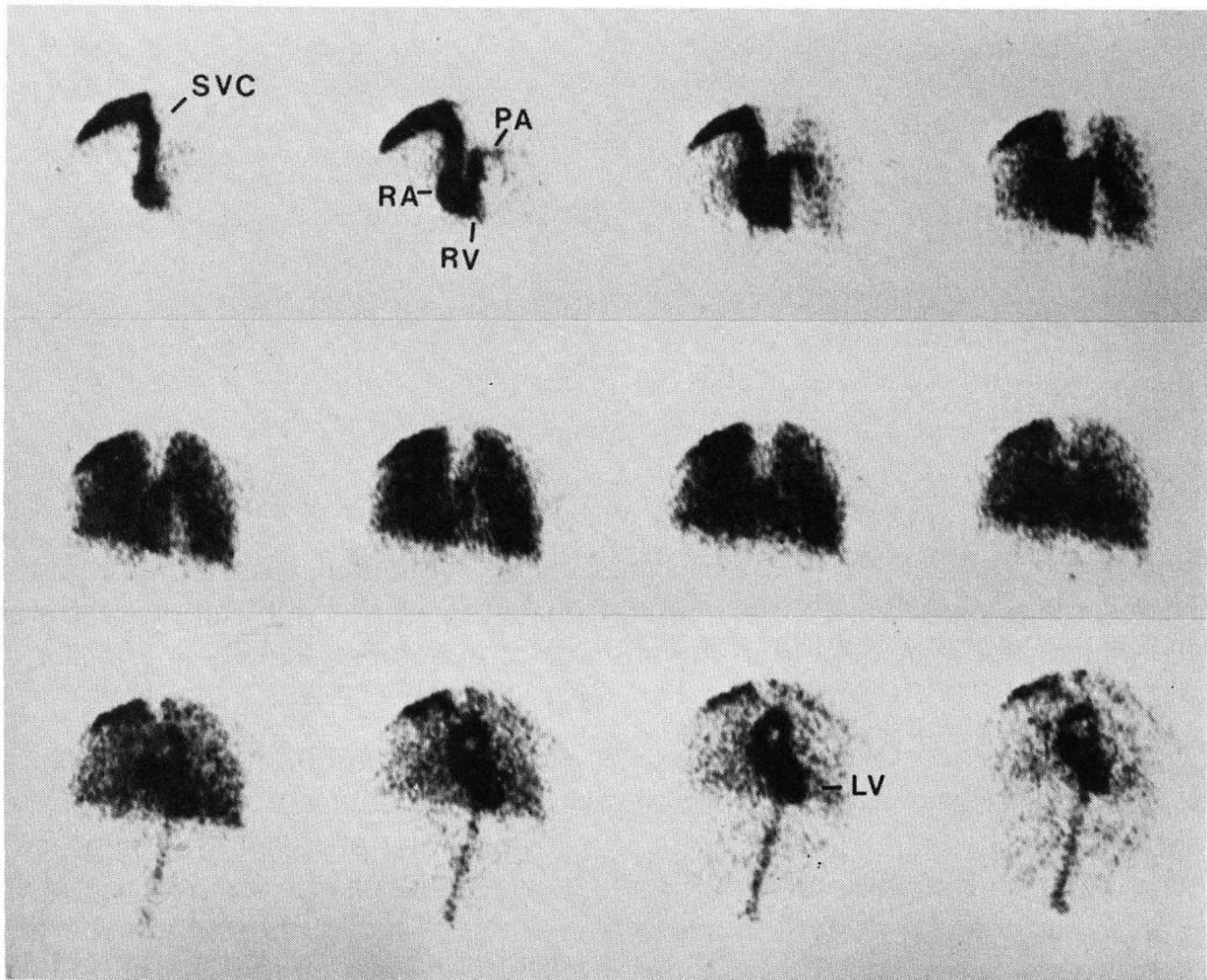
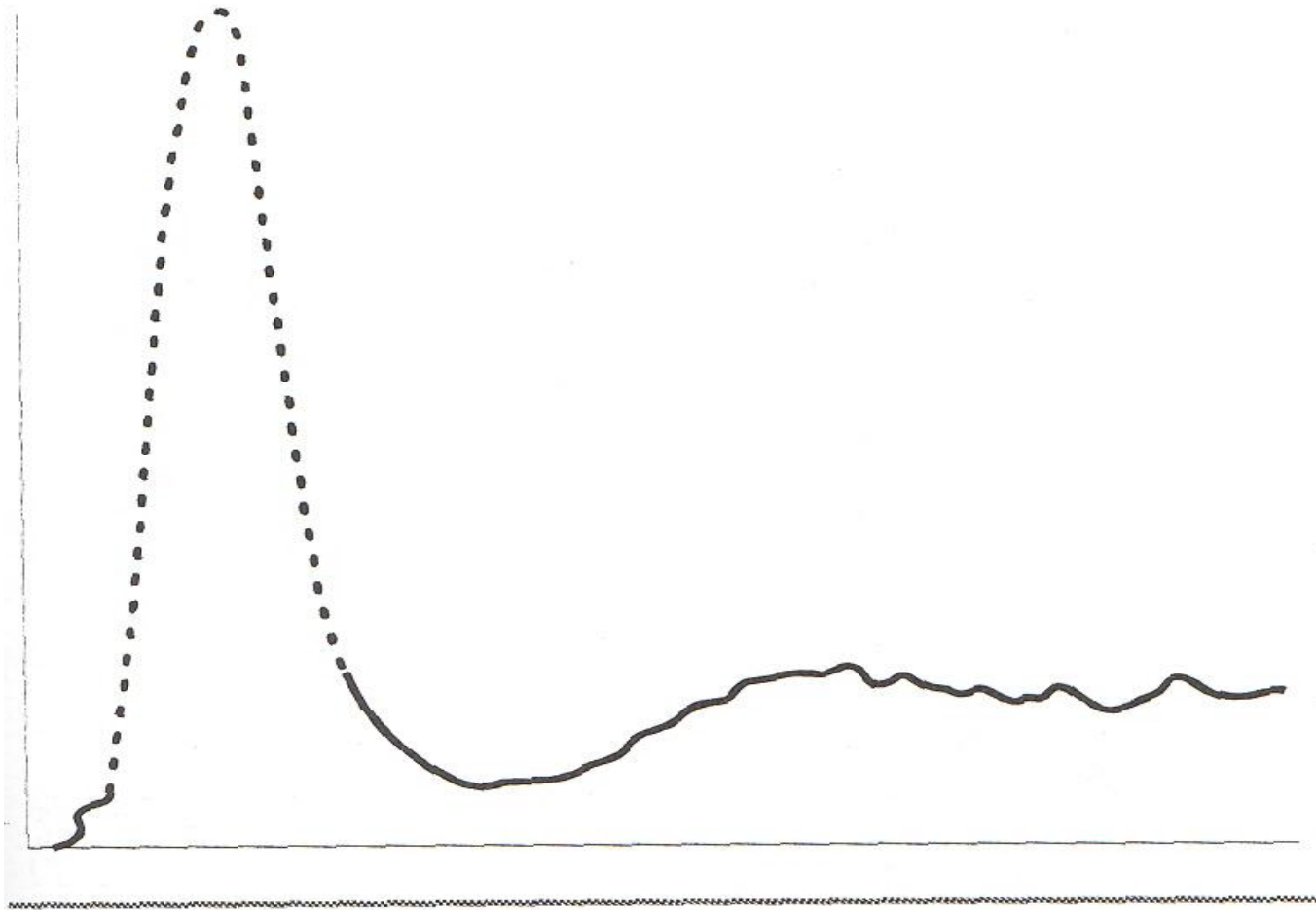
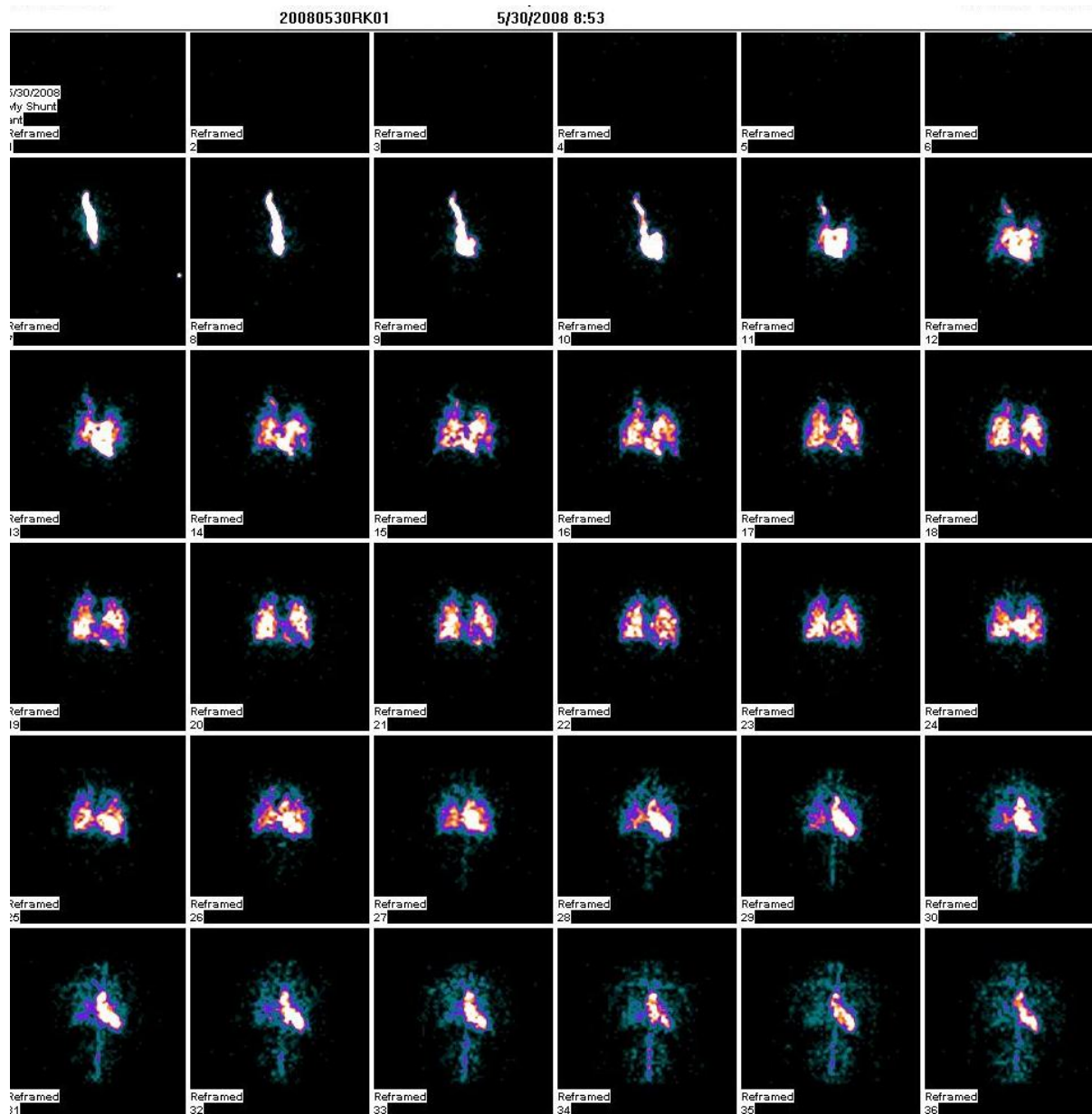


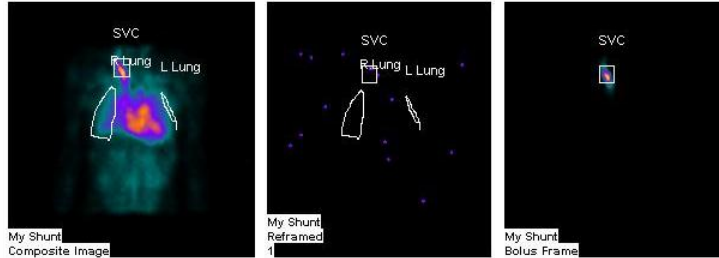
Fig. 19-1. Normal radionuclide angiogram in modified LAO position, using a converging collimator. Frames are at 1-sec intervals. SVC = superior vena cava, RA = right atrium, RV = right ventricle, PA = pulmonary artery, and LV = left ventricle. Left atrium is not visualized in this view.



Normal lung curve of radioactive indicator; left peak, which is higher and thinner, is showing first passthrough the heart, and right peak is showing recirculation of the systemic blood pool

Normal examination



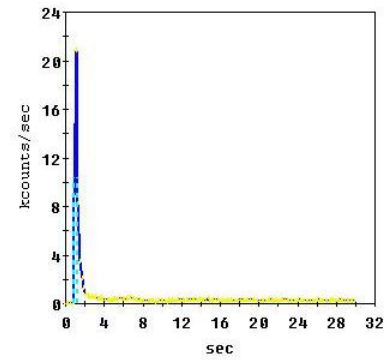


Lung Fr: 1@ 0.20 sec Bolus Fr: 6@ 1.20 sec

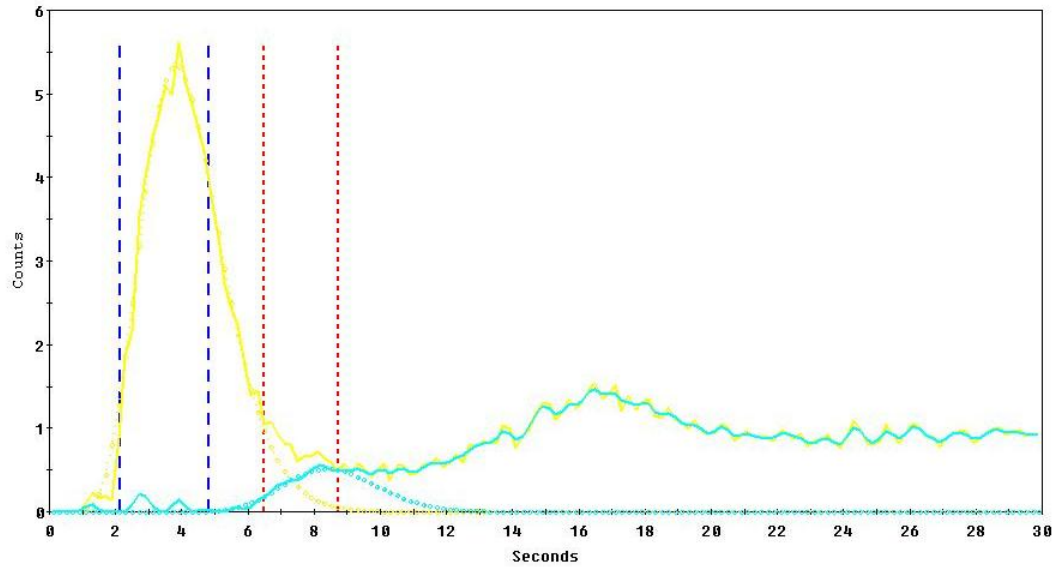
QP:QS= 1.00 (Negligible shunt area)

Bolus FWHM = 0.34 (0.93-1.26)

BolusCurve

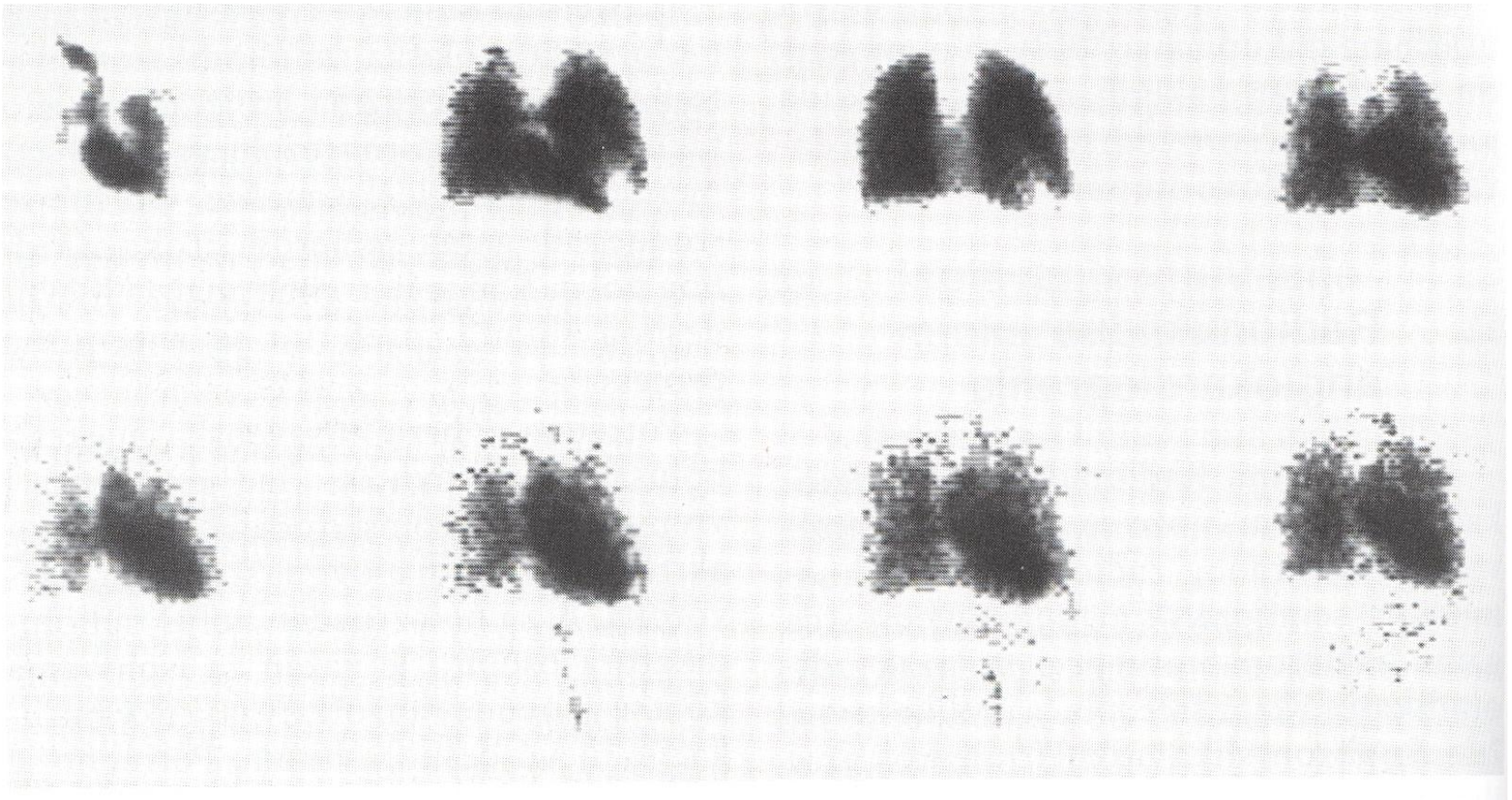


Lung Curve & Gamma Variate Fit Difference Curve & Gamma Variate Fit



L→R shunt

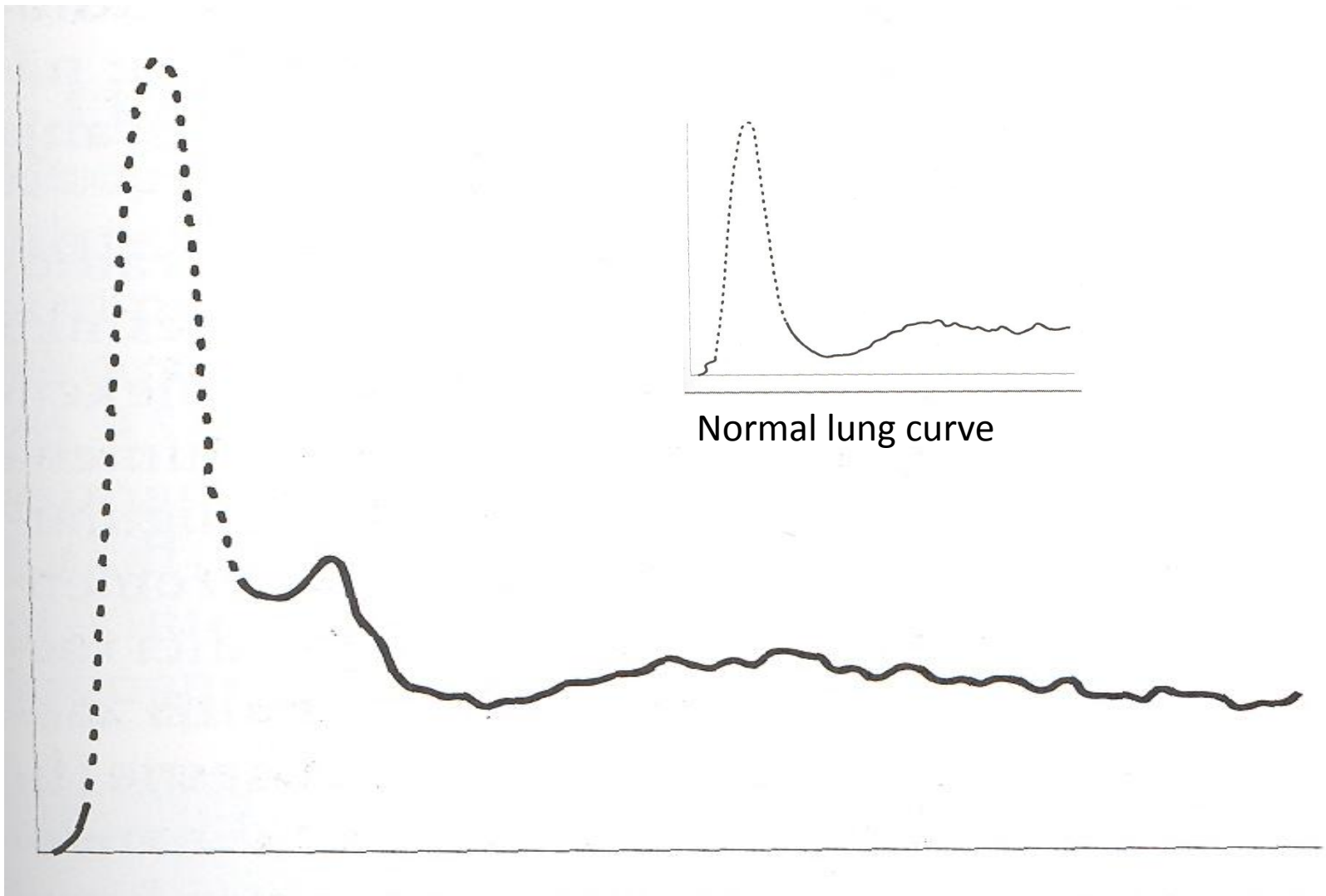
- Early recirculation of radiopharmaceutical in the left to right shunt
- Delayed elimination of radiopharmaceutical from the lung (higher blood-flow through lungs)
- Poor image of the left heart
- Identification and quantification of the shunt on the curve



Radionuclide angiocardigraphy in a patient with a ventricule septal defect

Midium big left-right shunt. Individual scintigrams represent 0,8 sec sequences.

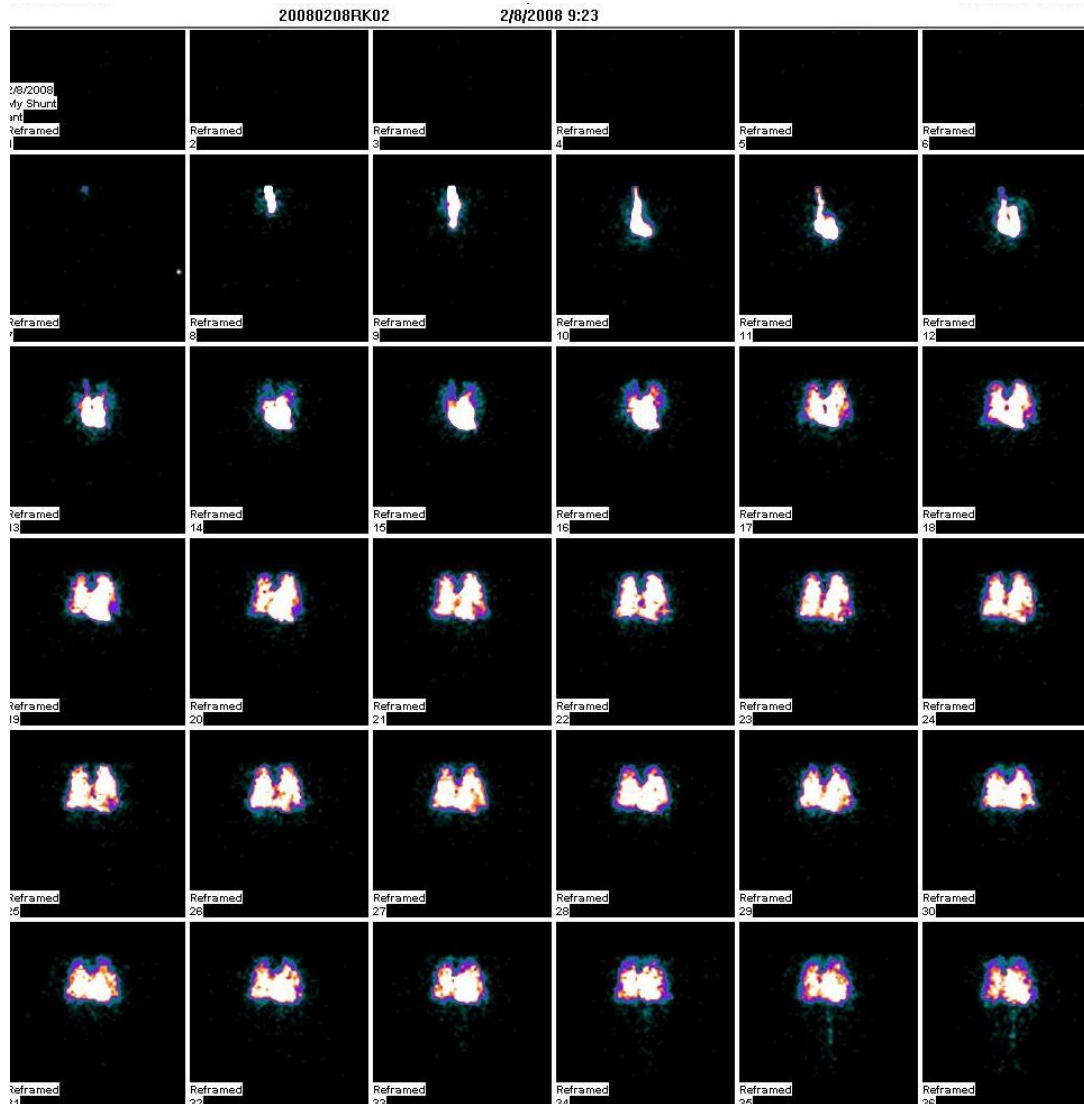
There is a delay of activity in the lungs due to early recirculation of radiopharmaceutical.



Normal lung curve

Lung curve in patient with left-to-right shunt: On descending slope of the curve, which represents first passage of the radionuclide, there is peak of early recirculation

L-R shunt



Quantification

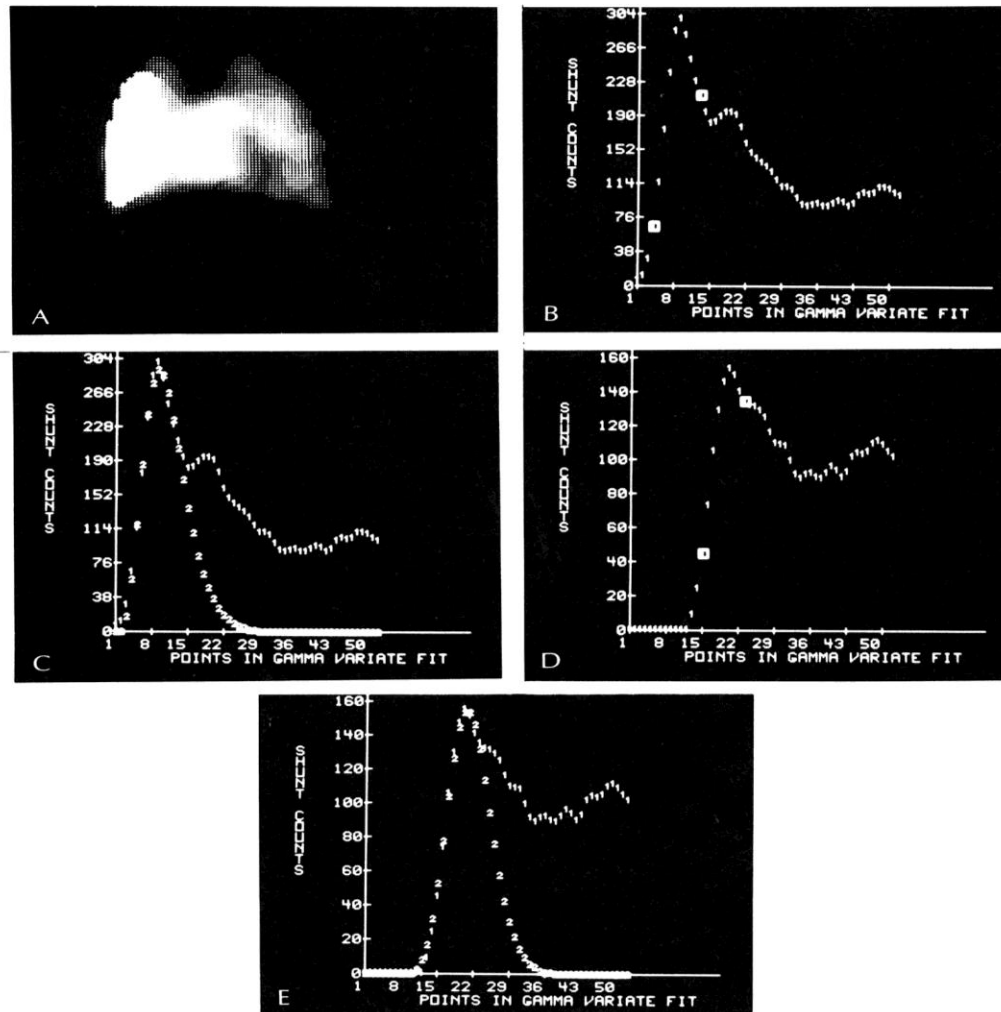


Fig. 19-6. Computer analysis of left-to-right shunting. *A.* ROI over right lung is highlighted over image that represents a composite of all frames. *B.* Time-activity curve of raw data with computer-selected points at 10% of upslope and 70% of downslope just before recirculation. *C.* Curve 2 is gamma variate fit of curve 1. *D.* Computer-generated recirculation curve from raw data. *E.* Curve 2 is gamma variate fit of recirculation data.

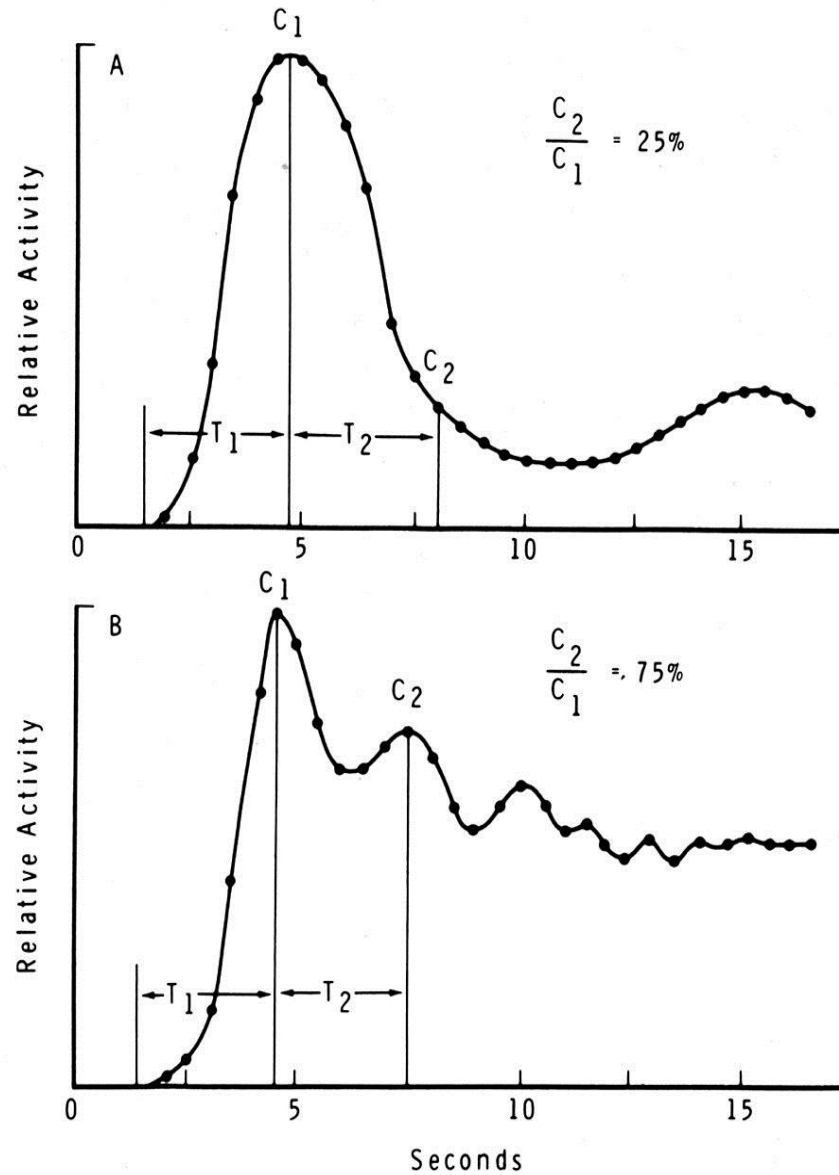
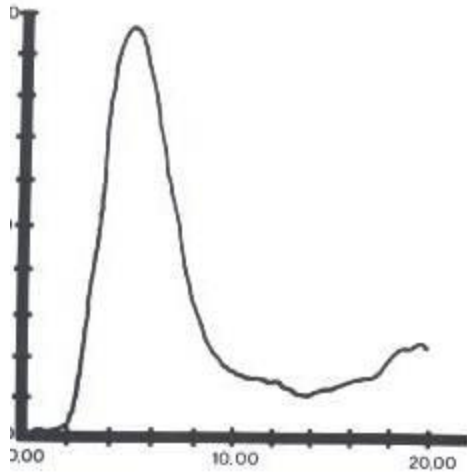


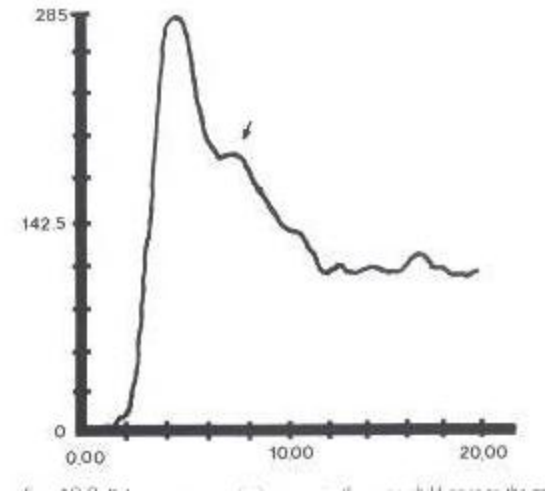
Fig. 19-5. Computer-generated time-activity curves from normal right lung (A) and from patient with severe left-to-right shunt (B).

Cardiac shunt lung curves



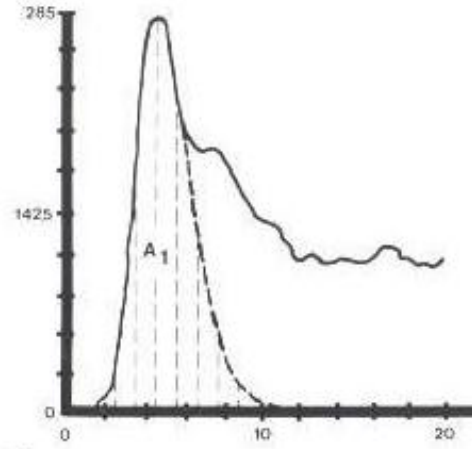
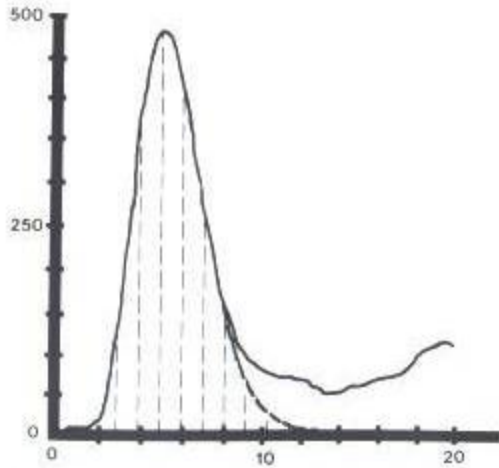
10-1. Pulmonary time-activity curve in a child after successful repair of

normal lung TAC
See physiological recirculation
at about 18s



Pathological lung TAC
See bump at the falling half
Of the lung curve

Modelling of ideal bolus injection

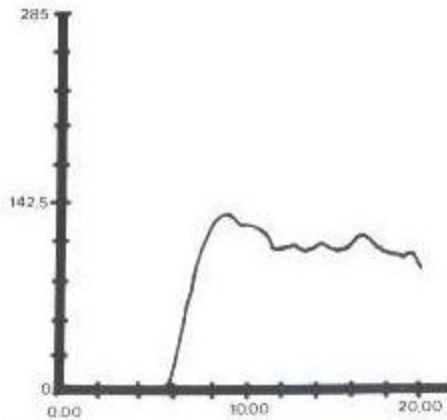


Gamma-Fit of
Normal curve

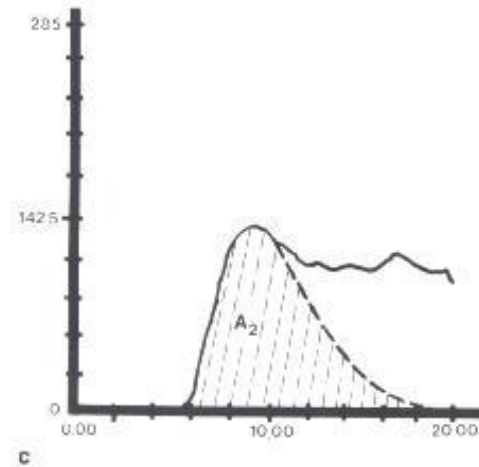
same input function

pathological curve:

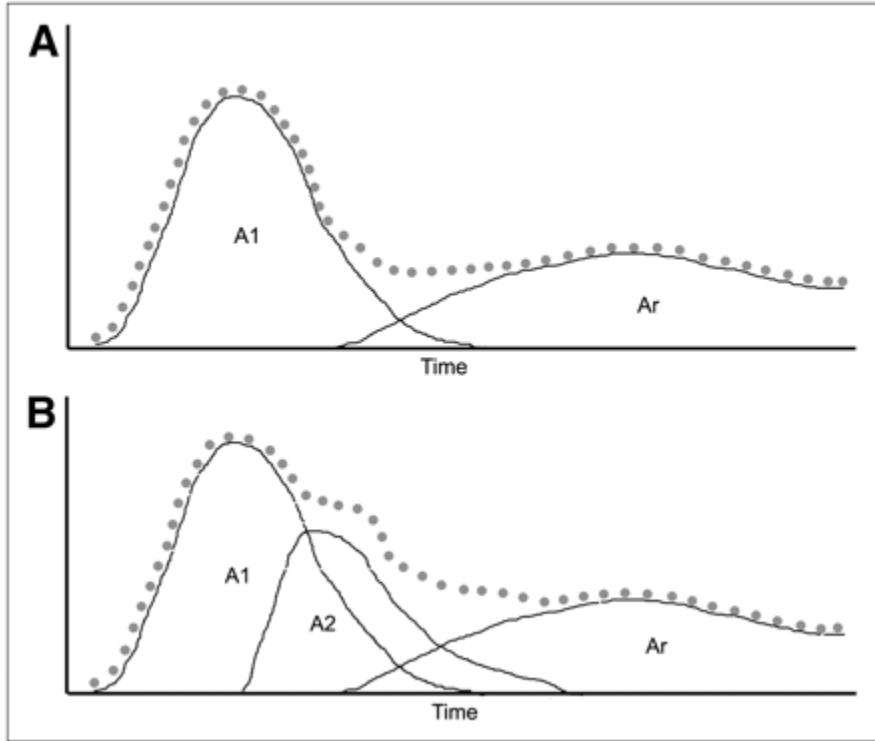
Analysis of difference

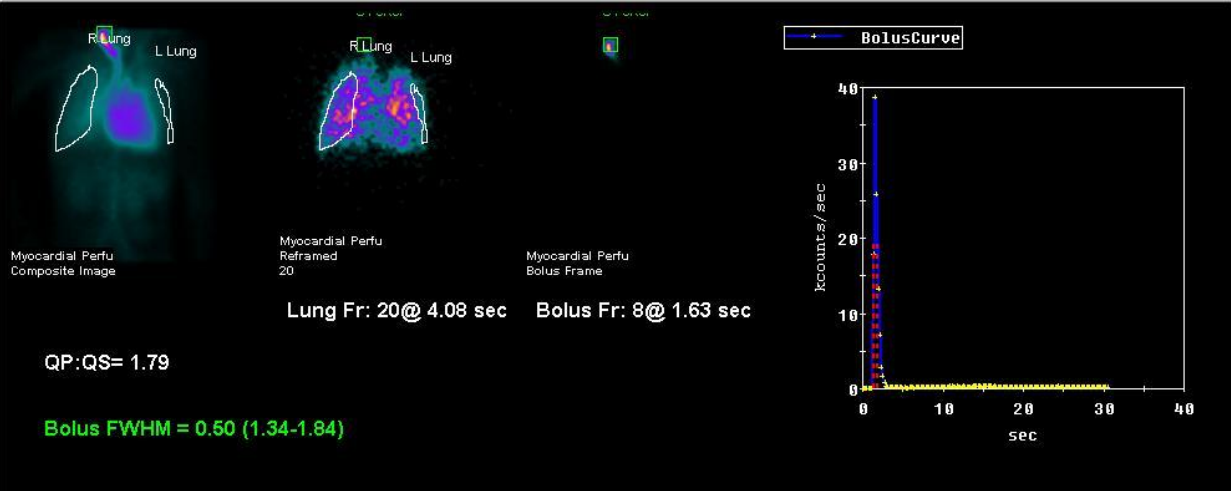


Difference between pathological
Curve and GammaFit equals shunt +
Physiological recirculation

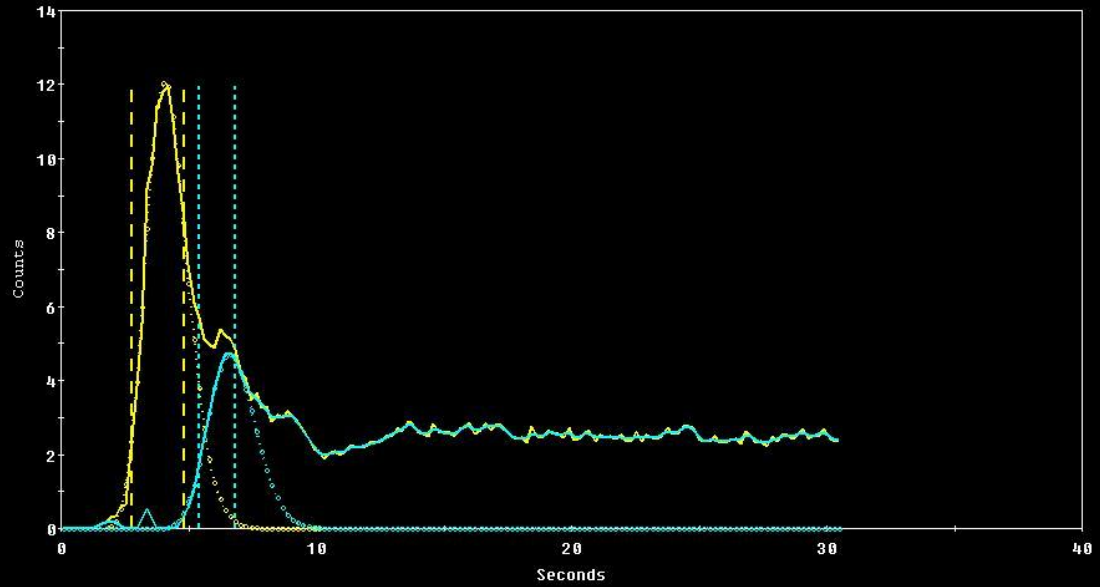


GammaFit of difference curve equals
shunt





— Lung Curve & Gamma Variate Fit — Difference Curve & Gamma Variate Fit



Indications for the FP-RA:

1. Detection, localization and quantification of the intracardiac shunt and shunt between large blood vessels
2. Follow-up of patients for the evaluation of the shunt's size, as well as for the detection of postsurgical residual shunt

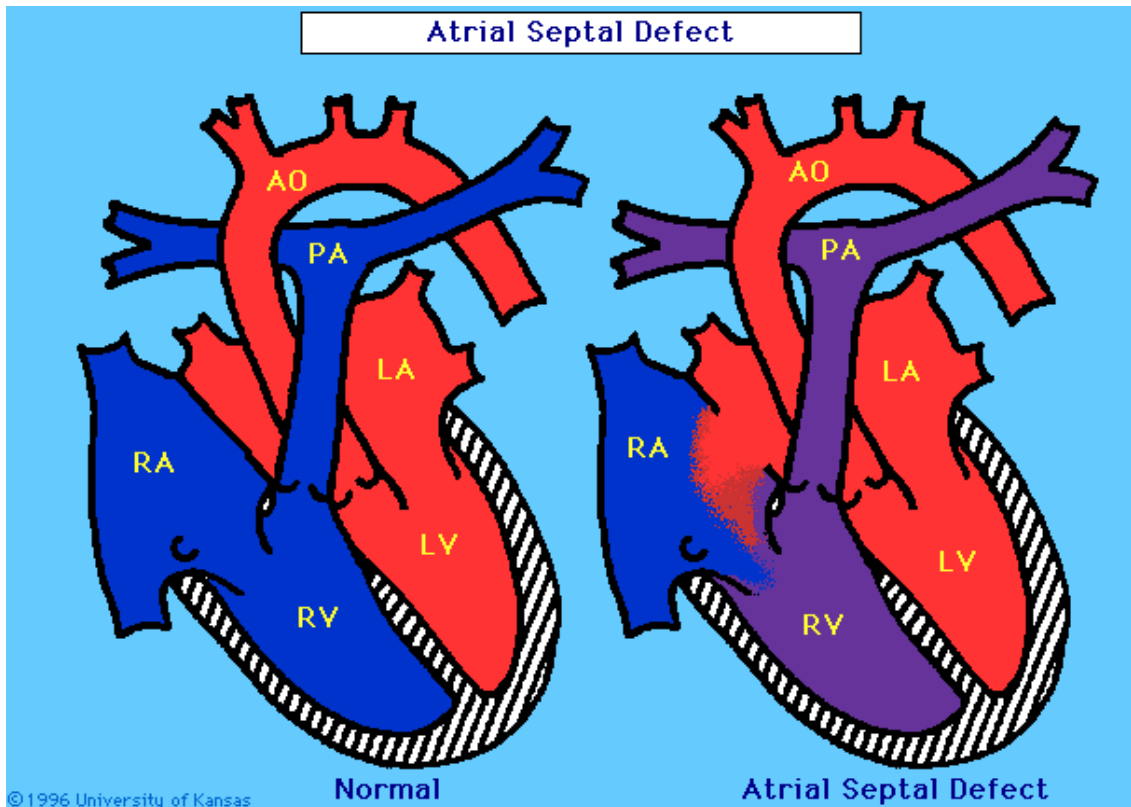
Congenital heart defects with left-to-right shunt and higher blood flow through the lungs

- **ASD:** 10 % of congenital heart defect in the childhood; ostium secundum (most often), ostium primum and sinus venosus
- **VSD:** most common congenital heart defect in the childhood (30%)
- **Ductus Botalli** (ductus arteriosus persistens), 8-10%; conjunction between aorta and left branch of the pulmonary artery

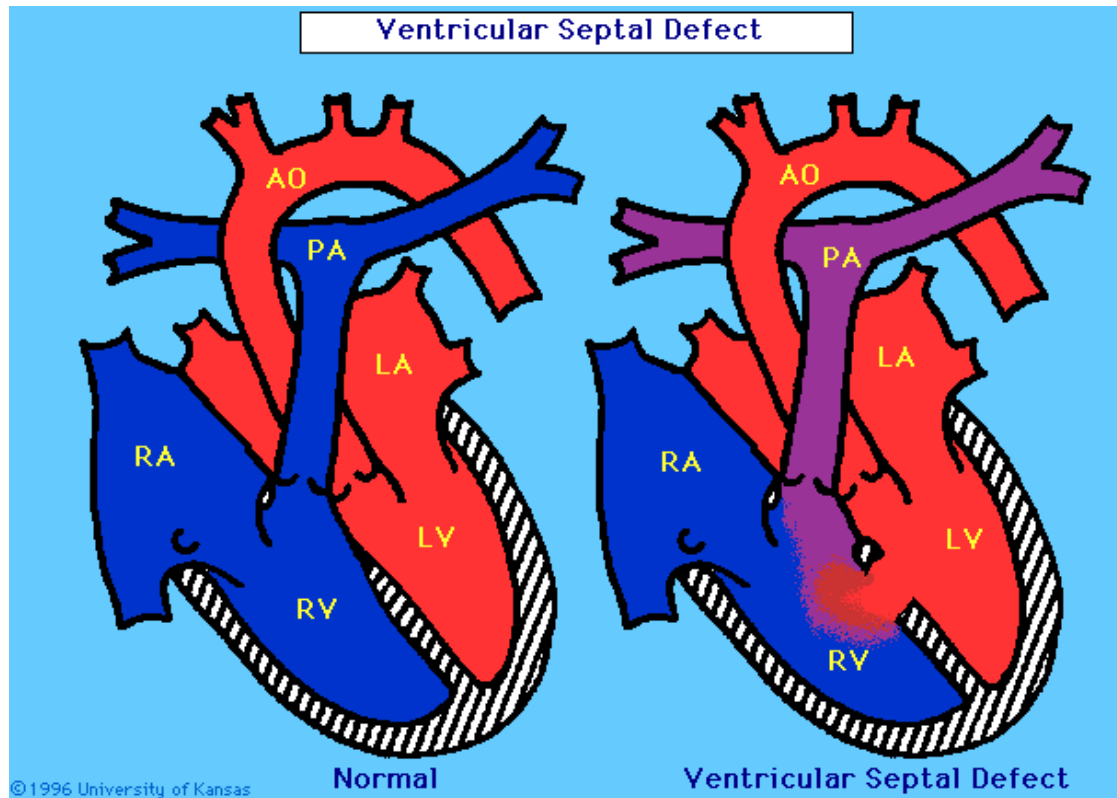
ASD

Prominent (enlarged) right ventricle which can fill out retrosternal space

Left atrium isn't enlarged because left atrium decompression is being formed in the right atrium through the defect



VSD



Enlarged heart shadow

Enlarged truncus pulmonale

Enlarged pulmonary heart vesseks

Congestive heart disease

Pan sistolic murmur

DUCTUS ARTERIOSUS PERSISTENT

DA – normal conjunction between aorta and pulmonary artery which is normally closed within 24 hours after birth or remains persistent until the second month of life, or less common until the end of the first year

Small conjunction – normal size of the heart

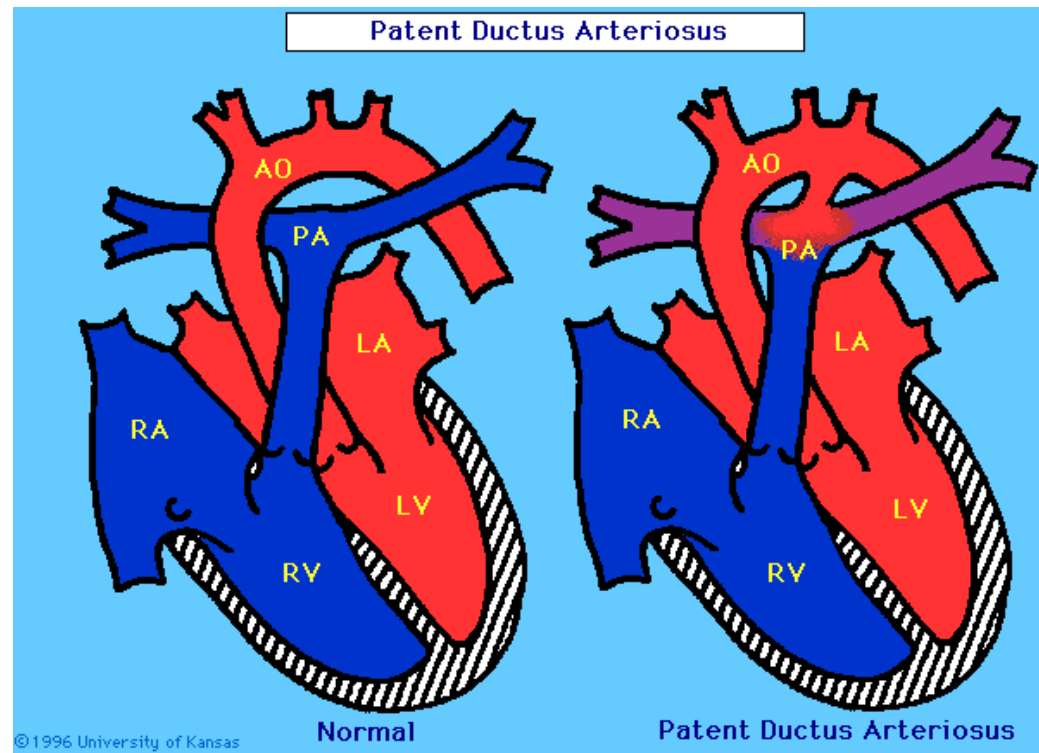
Wide ductus – bigger supply and blood flow load of the LA and LV →

expanded main branch of the pulmonary artery, depending of the flow wight of the perifer arteries is determined, sizing from the normal wight to the plethora

INCREASE OF THE BLOOD PRESSURE –
BIDIRECECTION SHUNT

EXERCISE CIANOSIS FURTHER INCREASE
OF THE BLOOD PRESSURE – RIGHT TO LEFT
SHUNT

CIANOSIS, EISENMENGER SY

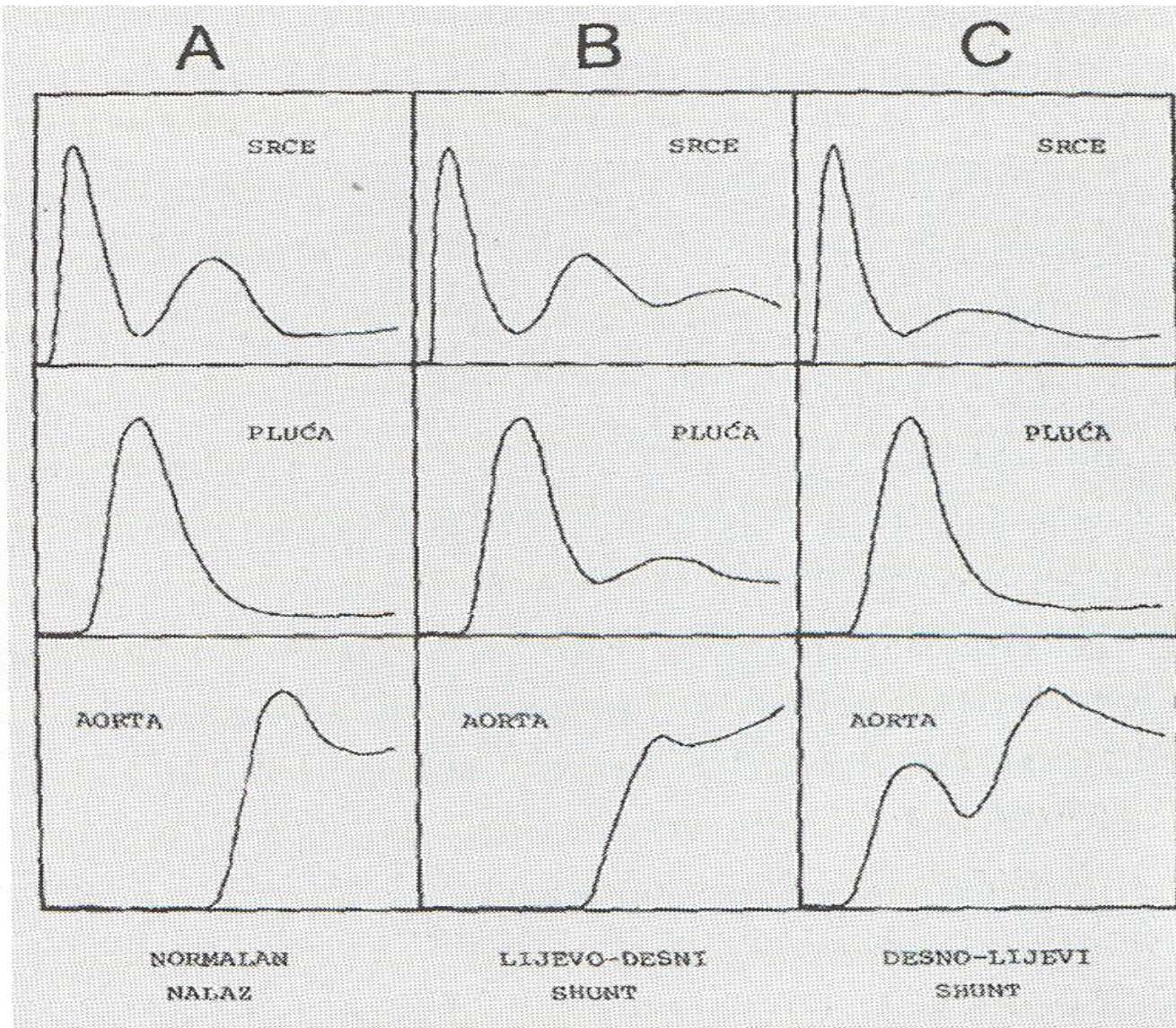


Congenital heart defects with right-to-left shunt, cyanosis and diminished blood flow through the lungs

- **Tetralogy Fallot (10%)**: pulmonary artery stenosis, VSD, hypertrophy of the right ventricle, ante – and dextraposition of the aorta origin
- **Tricuspidal atresia, TA (2%)**: shunt in the atria (and ventricles), blood arrives to the lungs through the other way; or through the ventricular septum in the right atrium and lungs, or through the persistent ductus Botalli
- **Ebstein anomaly**: anomaly formed tricuspidal valve, lies deep in the right ventricle, most often with defect in the atria with right-to-left shunt

Congenital defects with right-to-left shunt and cyanosis

- Transposition of the large arteries, d-TVA (5,4%)
- Adjusted transposition of the large arteries, l-TVA
- Exit of both arteries from the right ventricle, “double outlet”
- joint ventricle
- Truncus arteriosus persistens



Schematic representation of curve activities of the heart, lung and aorta:
 A. Normal, B. Left-to-right shunt, C. Right-to-left shunt

SYNDROMA EISENMENGER

All congenital heart disease with left-to-right shunt can form secondary pulmonary hypertension

Pulmonary arteries' response to increased blood flow and hyperkinetic circulation is vasoconstriction

Permanent organic changes are formed because of the thickening of the media of the vessels and proliferation of the intima in the pulmonary arteries

Increase in the central pressure causes bidirectional blood flow in the right ventricle, and further increase of the pressure causes irreversible right-to-left flow permanent cyanosis

X-ray: peripheral vascular image is reduced – oligemia, with weight (enlarged)

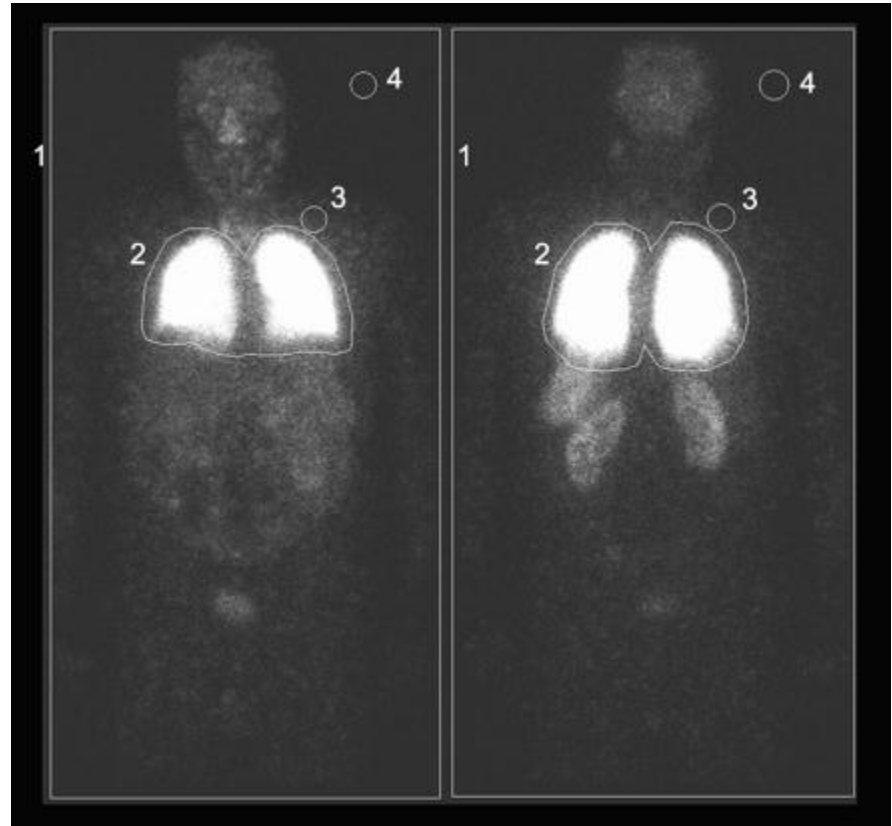
HILOPULMONARY PART OF THE PULMONARY ARTERY, PROTRUDING TRUNCUS PULMONALE

RIGHT-LEFT shunt

- Early pass of radiopharmaceutical from the right to the left heart and it's arrival to the aorta (and systemic circulation) at the same time as the arrival of the radiopharmaceutical to the lung



MAA- normal finding, no right to left shunt



R-L shunt

- Tc-99m-MAA (size of the particles 10-20 μm), after the intravenous injection they are almost entirely “captured” in the first capillary system (lungs), dosage 100 – 400 μCi
 - $>3\%$ pass – characteristic for the right-to-left shunt
- $\% \text{ shunt} = (\text{whole body activity} - \text{lung activity} / \text{whole body activity}) \times 100$

R→L shunt

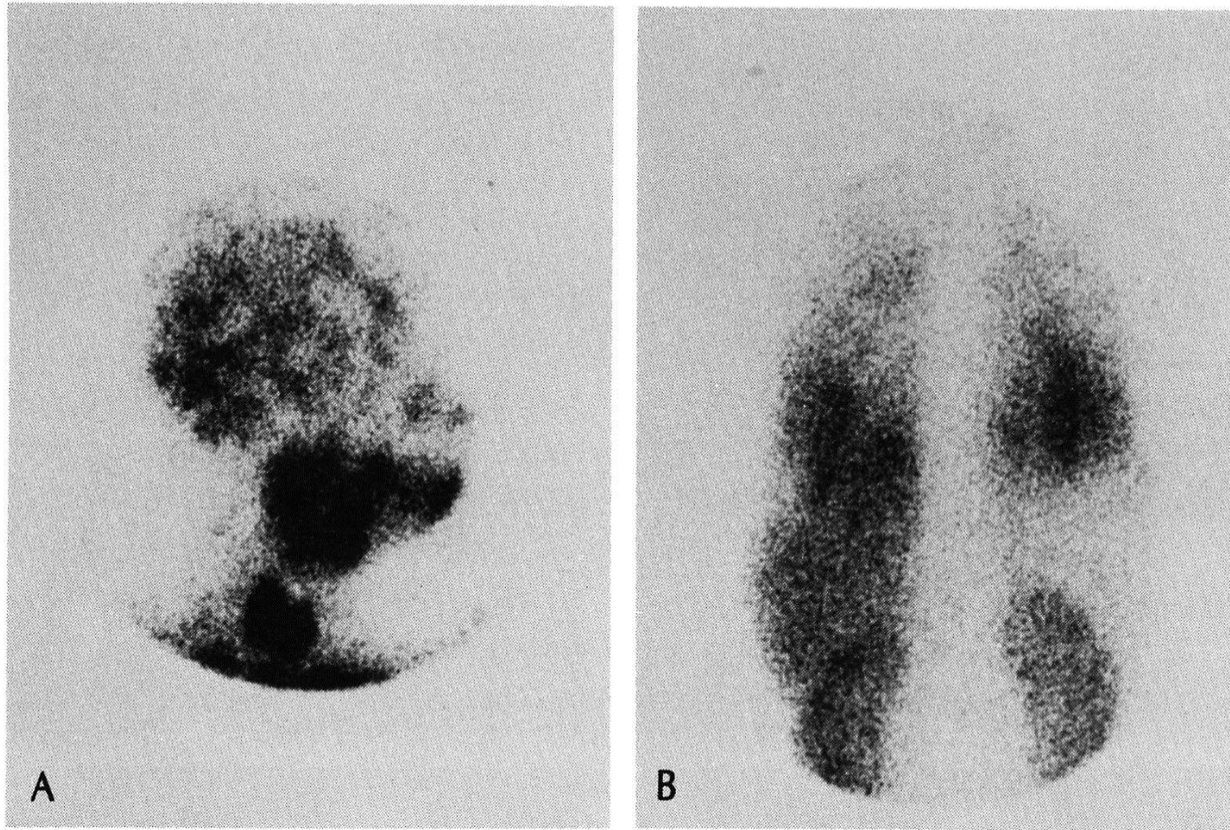


Fig. 19–8. Right lateral image of head, *A*, and posterior image of lungs and thorax, *B*, following intravenous injection of 3 mCi (111 MBq) Tc-99m MAA in a patient with marked right to left shunt. Activity in systemic organs is proportional to blood flow.

R→L shunt

- Tc-99m-MAA
- Accumulation of the radiopharmaceuticals in the brain and kidneys .

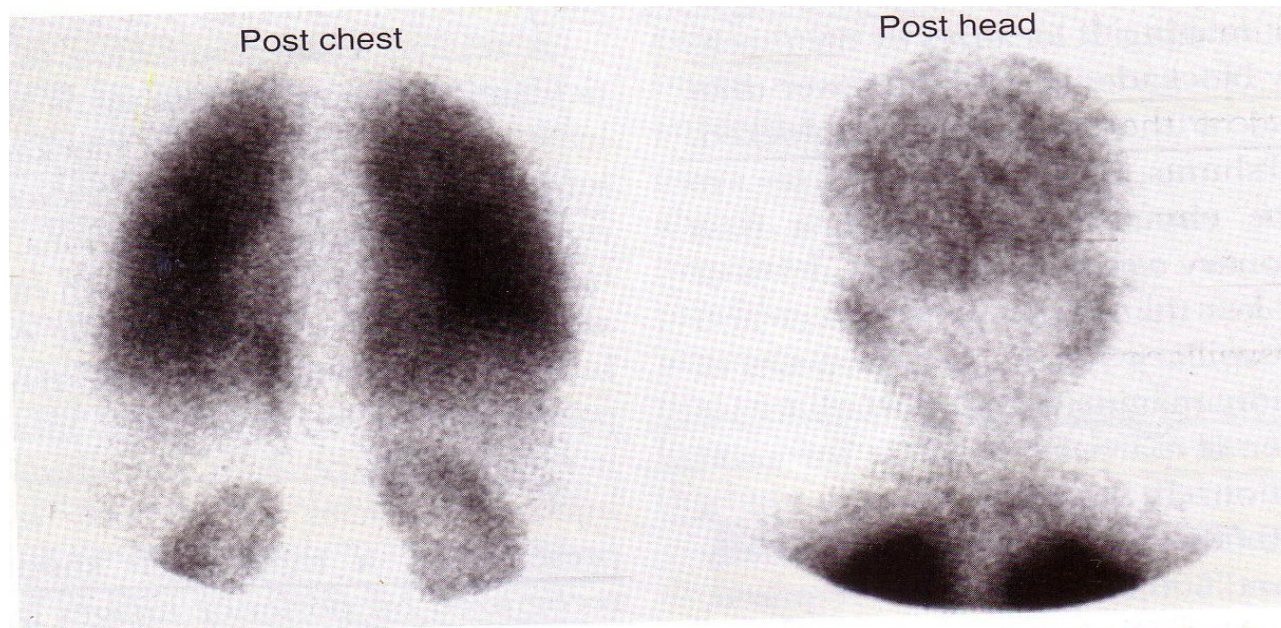
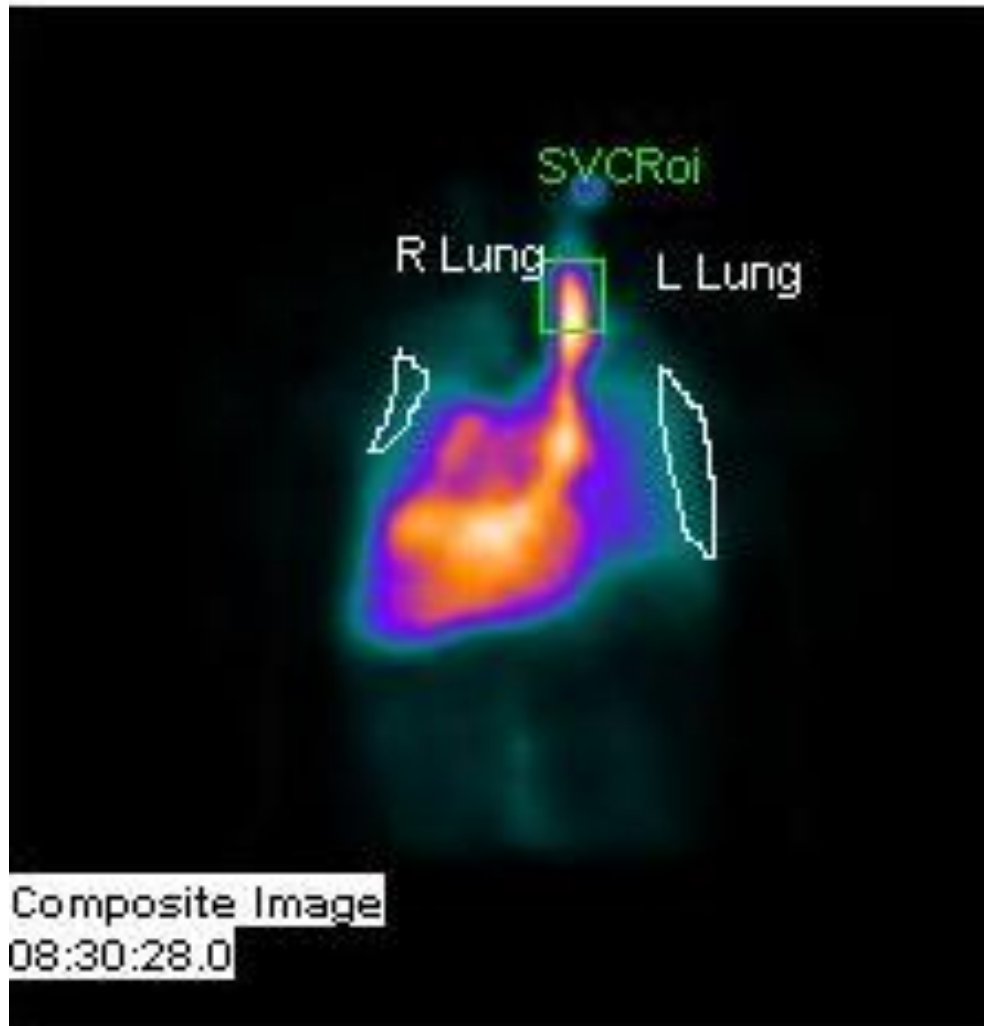
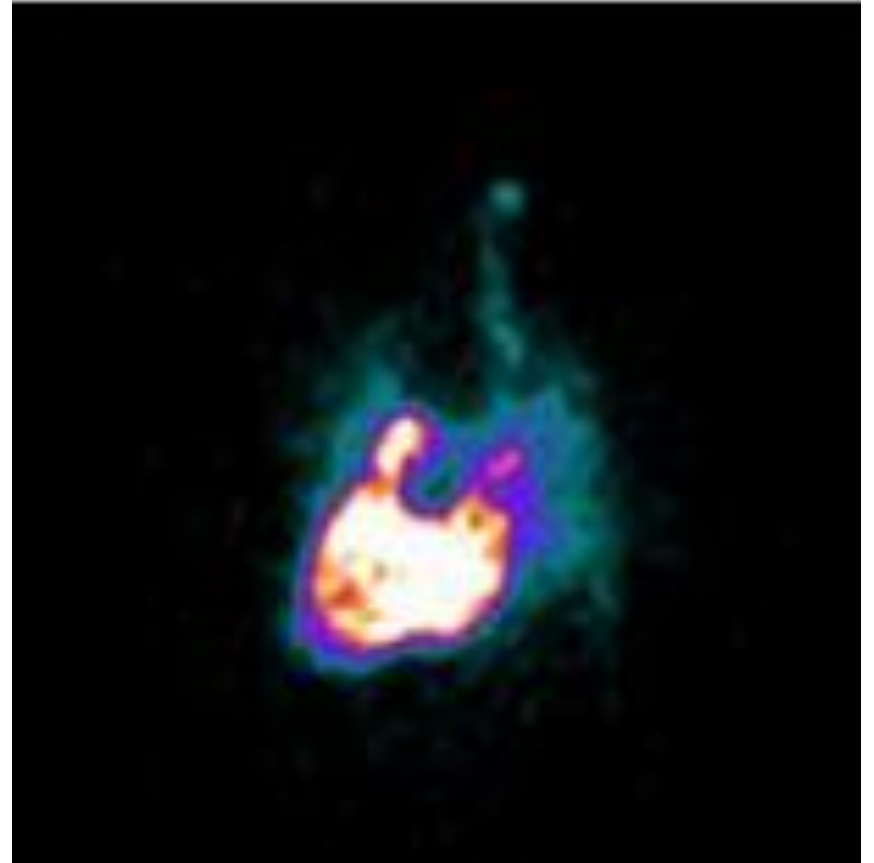
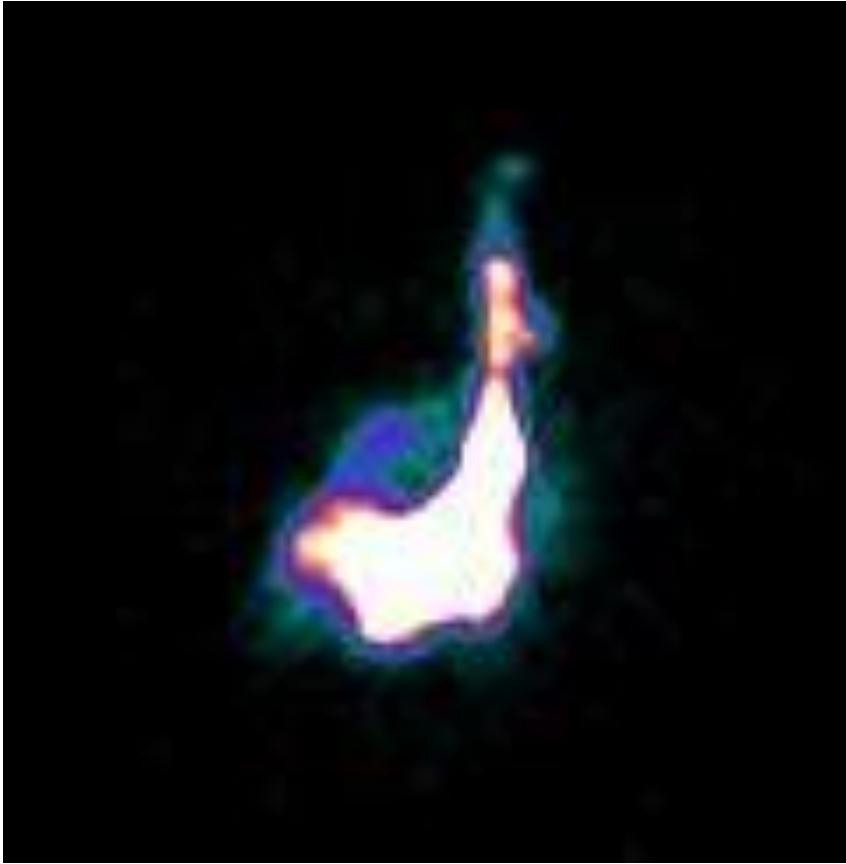


FIGURE 7-3. Right-to-left shunt. Two posterior images from a perfusion lung scan show ^{99m}Tc -macroaggregated albumin in the capillary bed of the kidneys and the brain.

Dextrocardia



Dextrocardia, Tetralogia Fallot, dilatated right atrium and ventricul



The end