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-99-m 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
L-R Cardiac Shunt Analysis

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)
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 angiocardiography in a patient with a ventricle 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.
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

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 pathological curve:
same input function
Analysis of difference

Difference between pathological Curve and GammaFit equals shunt + Physiological recirculation

GammaFit of difference curve equals shunt
Lung Fr: 20 @ 4.08 sec  Bolus Fr: 8 @ 1.63 sec

QP: QS = 1.79

Bolus FWHM = 0.50 (1.34-1.84)
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%; conjunzione 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
Enlarged heart shadow
Enlarged truncus pulmonale
Enlarged pulmonary heart vessels
Congestive heart disease
Pan sistolic murmor
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 on the flow weight of the peripheral arteries is determined, sizing from the normal weight to the plethora

INCREASE OF THE BLOOD PRESSURE – BIDIRECTION SHUNT

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

CIANOSIS, EISENMENGER SY
Congenital heart defects with right-to-left shunt, cianosis and diminished blood flow through the lungs

- **Tetralogy Fallot** (10%): pulmonary aretry stenosis, VSD, hypertrophy of the right ventricle, ante – and dextraposition of the aorta origin

- **Tricuspidal atresia**, TA (2%): shunt in the atria (and ventriculs), blood arrives to the lungs through the other way; or through the ventricular septum in the right atrium and lungs, or throuhg the persistent ductus Botally

- **Ebstein anomaly**: anomaly formed tricuspidal valve, lies deep in the right ventricule, 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 ventricul, “double outlet”
- joint ventricul
- 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 hyperketic circulation is vasoconstruction.

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 r+to leftt shunt

R-L shunt
• Tc-99m-MAA (size of the particels 10-20 µm), after the intravenous injection they are allmost entirely “captured” in the first capillary system (lungs), dosage 100 – 400 µCi

• >3% pass – caracteristic for the right-to-left shunt

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\text{% shunt} = \left(\frac{\text{whole body activity} - \text{lung activity}}{\text{whole body activity}}\right) \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