

The Heart

Radiation Oncology & The Heart

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Overview

- ⊗ Cancer and the heart
- ⊗ Treatment effects on the heart
- ⊗ Techniques to minimise effect

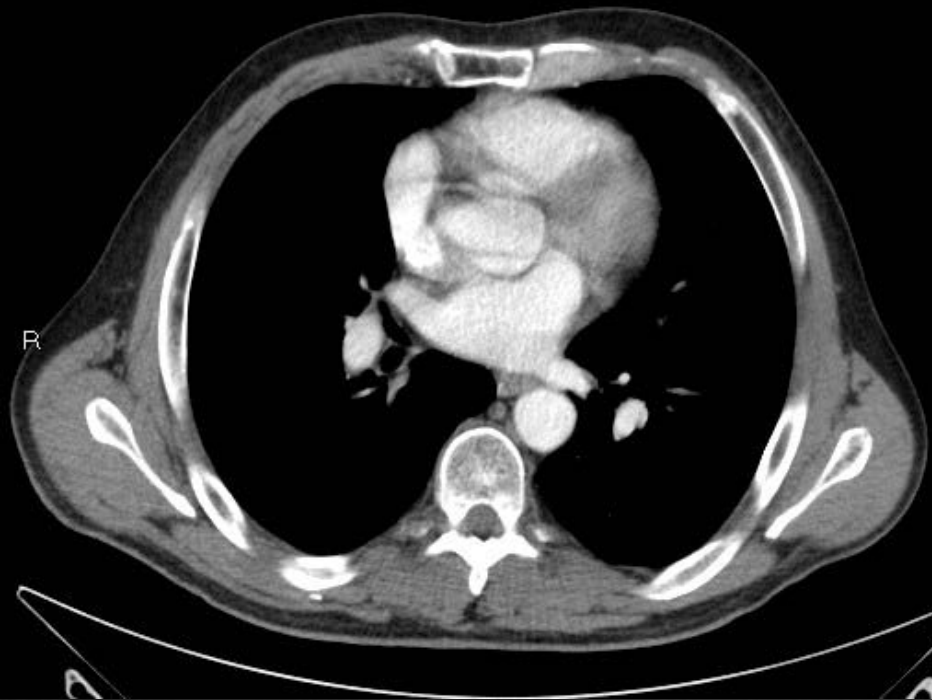
Cancer and the heart

- ⊗ Primary disease
 - ⊗ Soft tissue sarcoma
 - ⊗ Median survival 18 months
 - ⊗ Myxoma

- ⊗ Metastatic disease
 - ⊗ Melanoma
 - ⊗ Bronchogenic
 - ⊗ Renal

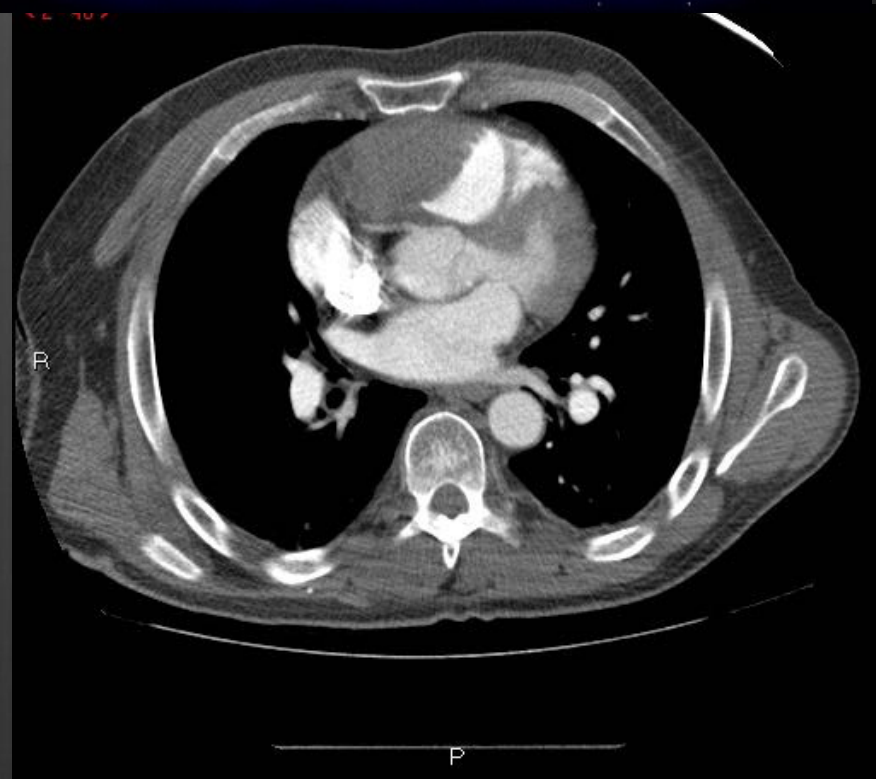
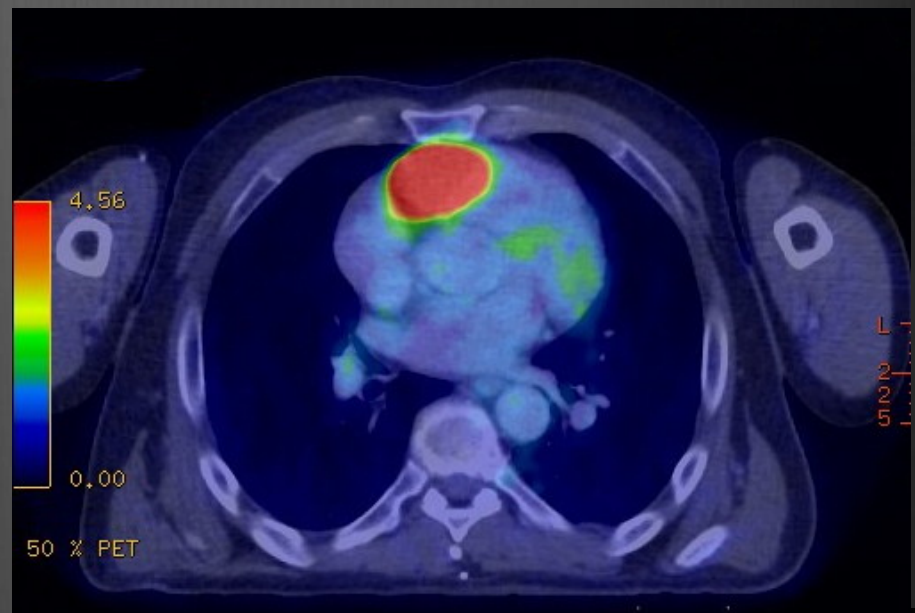
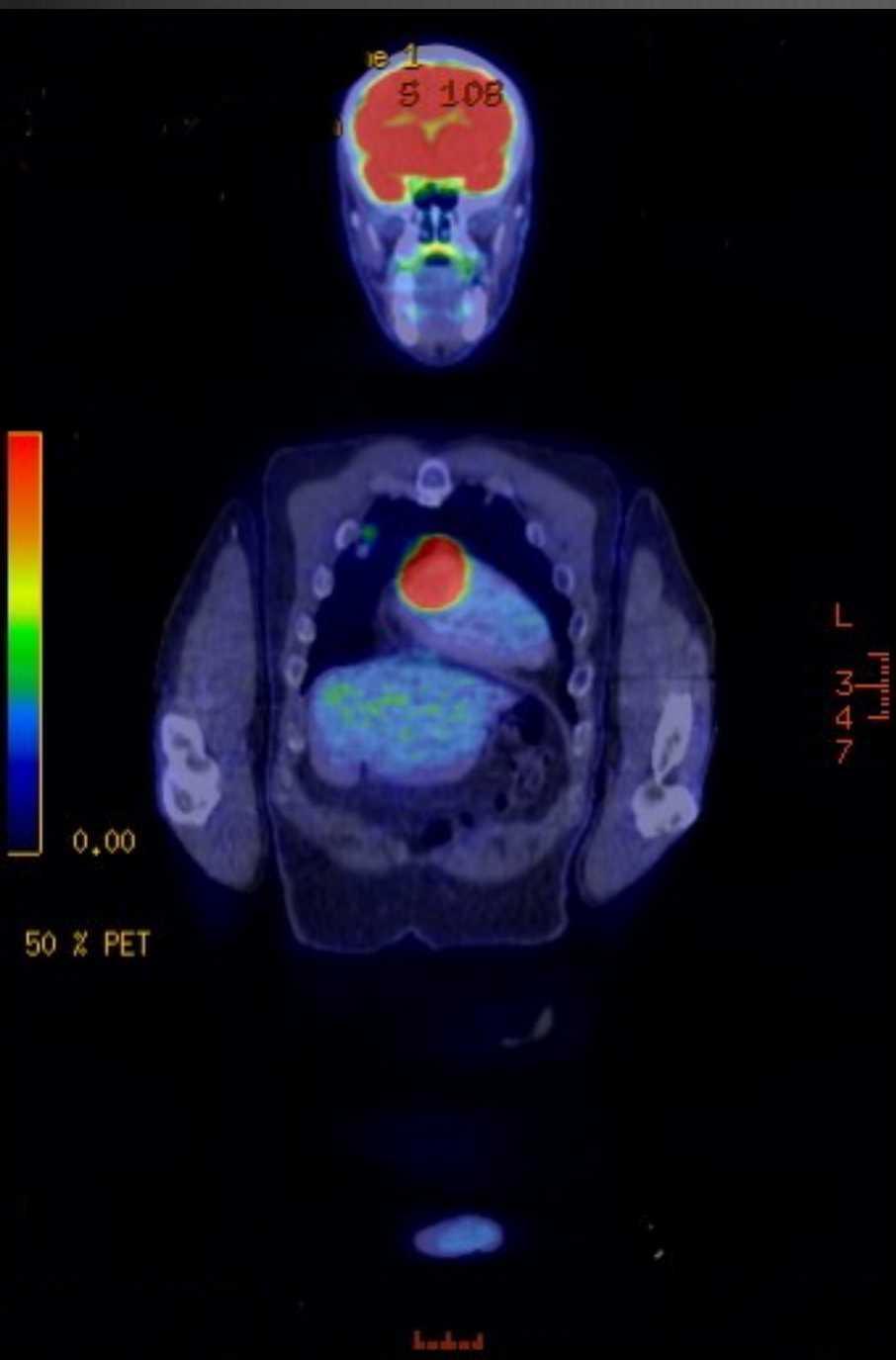
Normal CT?

< 4 - 37 ARTERIAL PHASE >



< 6 - 178 ARTERIAL THIN >







Radiotherapy Treatments

- ⊗ Breast treatment tangential fields, IMC fields, boost fields
- ⊗ Lung mediastinal dose
- ⊗ Oesophagus mediastinal dose
- ⊗ Hodgkins mediastinal dose
- ⊗ Medulloblastoma mediastinal dose
- ⊗ Thymoma mediastinal dose

Heart effects

- ⊗ Pericardium
- ⊗ Myocardium
- ⊗ Coronary arteries
- ⊗ Valves
- ⊗ Conducting system

Cardiac DVH

- ⊗ Mean cardiac dose not much use as dose to specific areas more relevant eg left anterior descending coronary artery
- ⊗ Dose-response analysis of late cardiac effects after radiotherapy requires detailed individual dosimetry
- ⊗ 769 breast cancer pts treated with tangents
 - ⊗ Left side: mean dose 0.9 – 19.1 Gy (4.6)
 - ⊗ Right side: mean dose 0.3 – 11.6 Gy (1.4)
- ⊗ Different doses in cardiac sub-structures
- ⊗ Mean dose used in various risk prediction models

Breast RT

- 3DCRT

- Mean heart dose 4.5 Gy

- $V_{40} = 2.6\%$

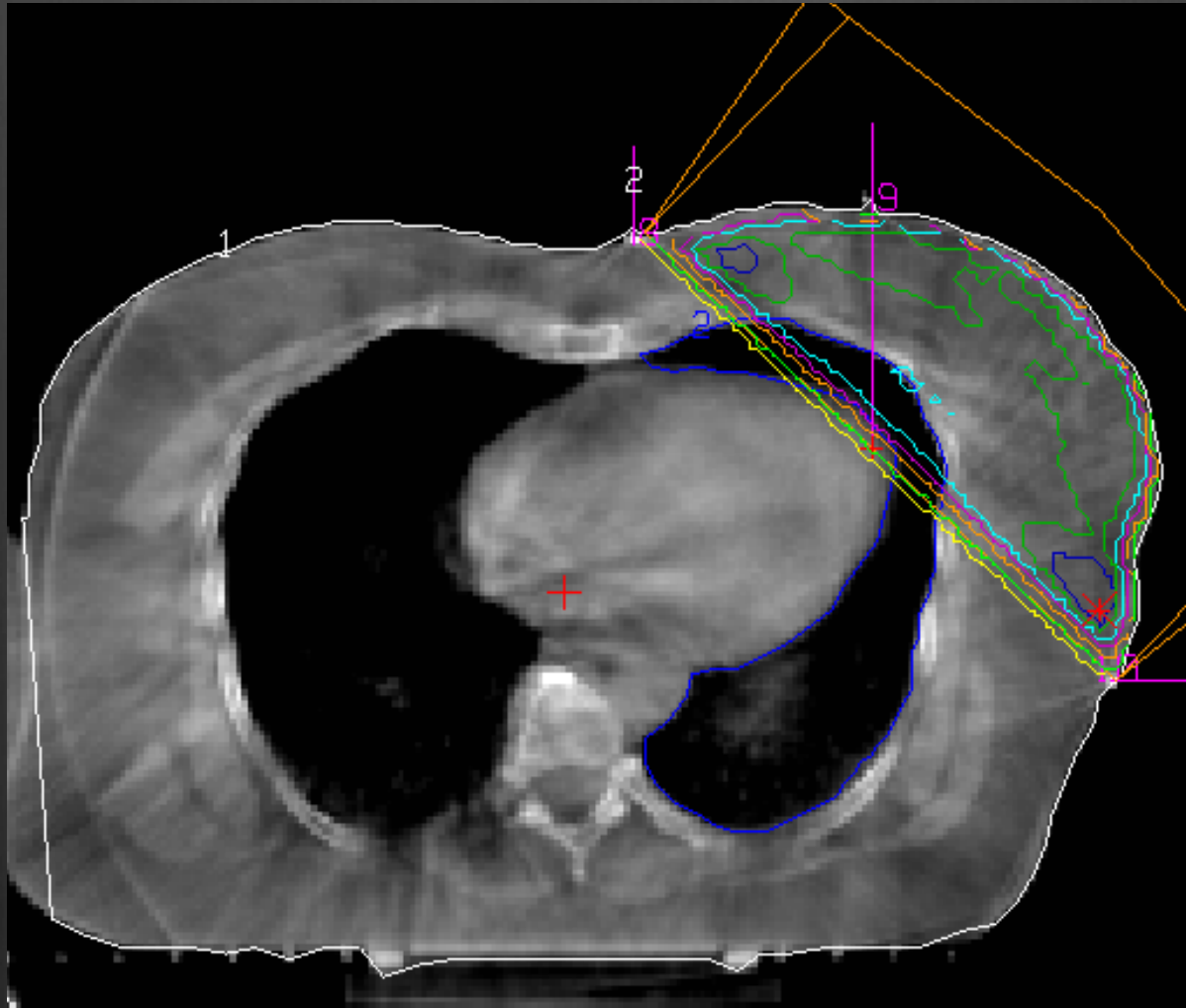
- IMRT

- Mean heart dose 12.9 Gy

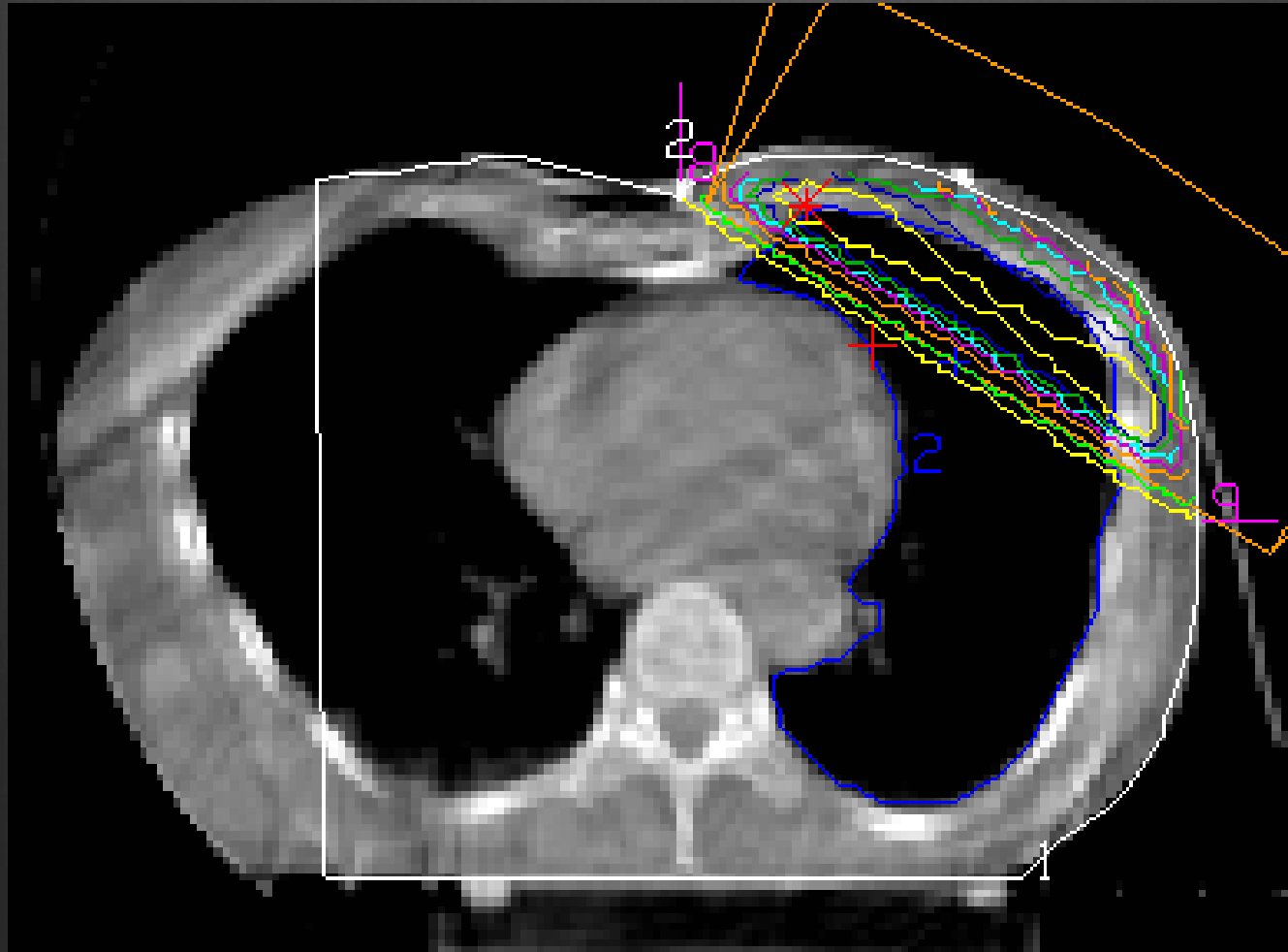
- $V_{40} = 1.3\%$

- Subclinical effects found in both groups at 24 months

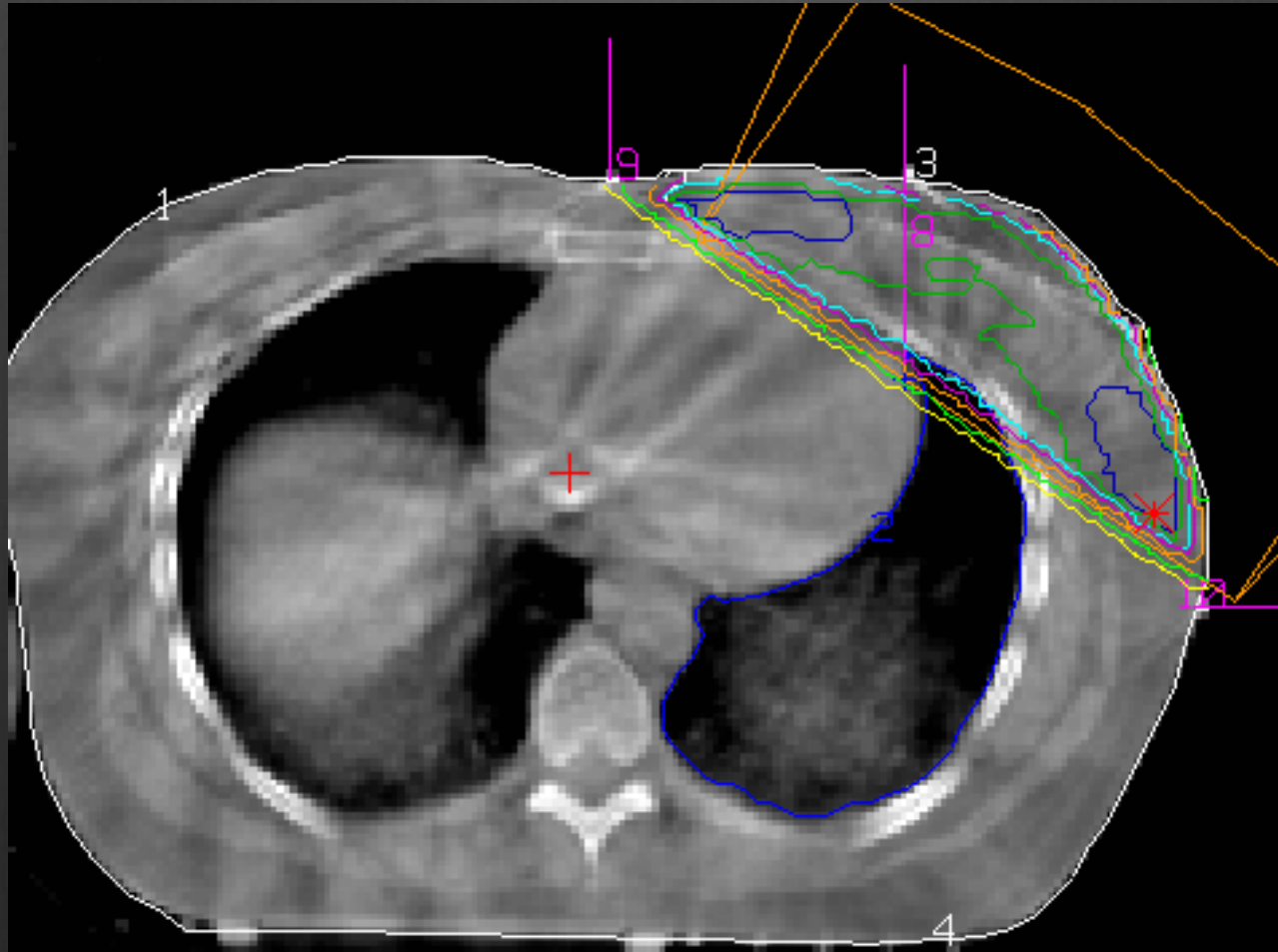
Left



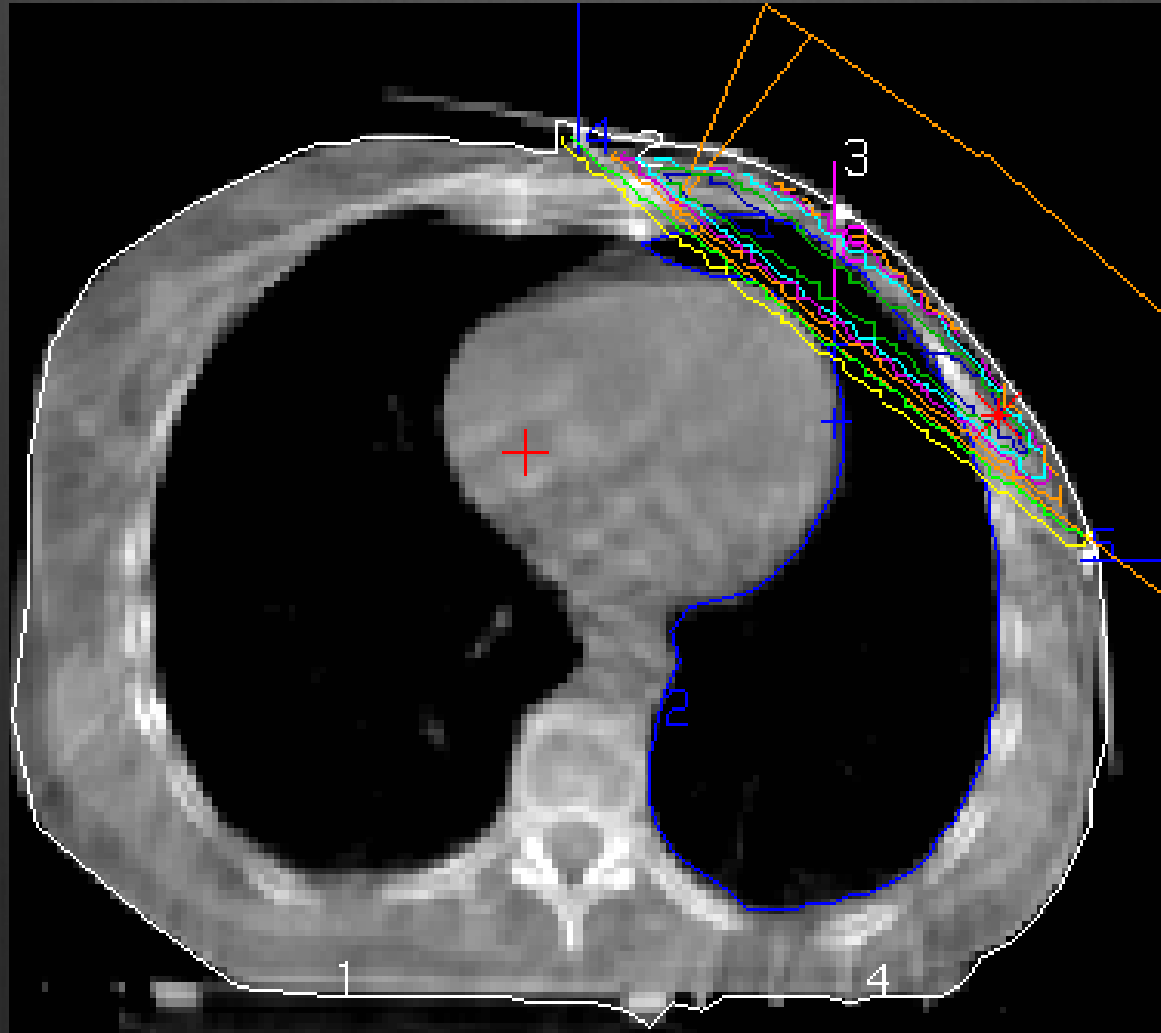
Left Pectus



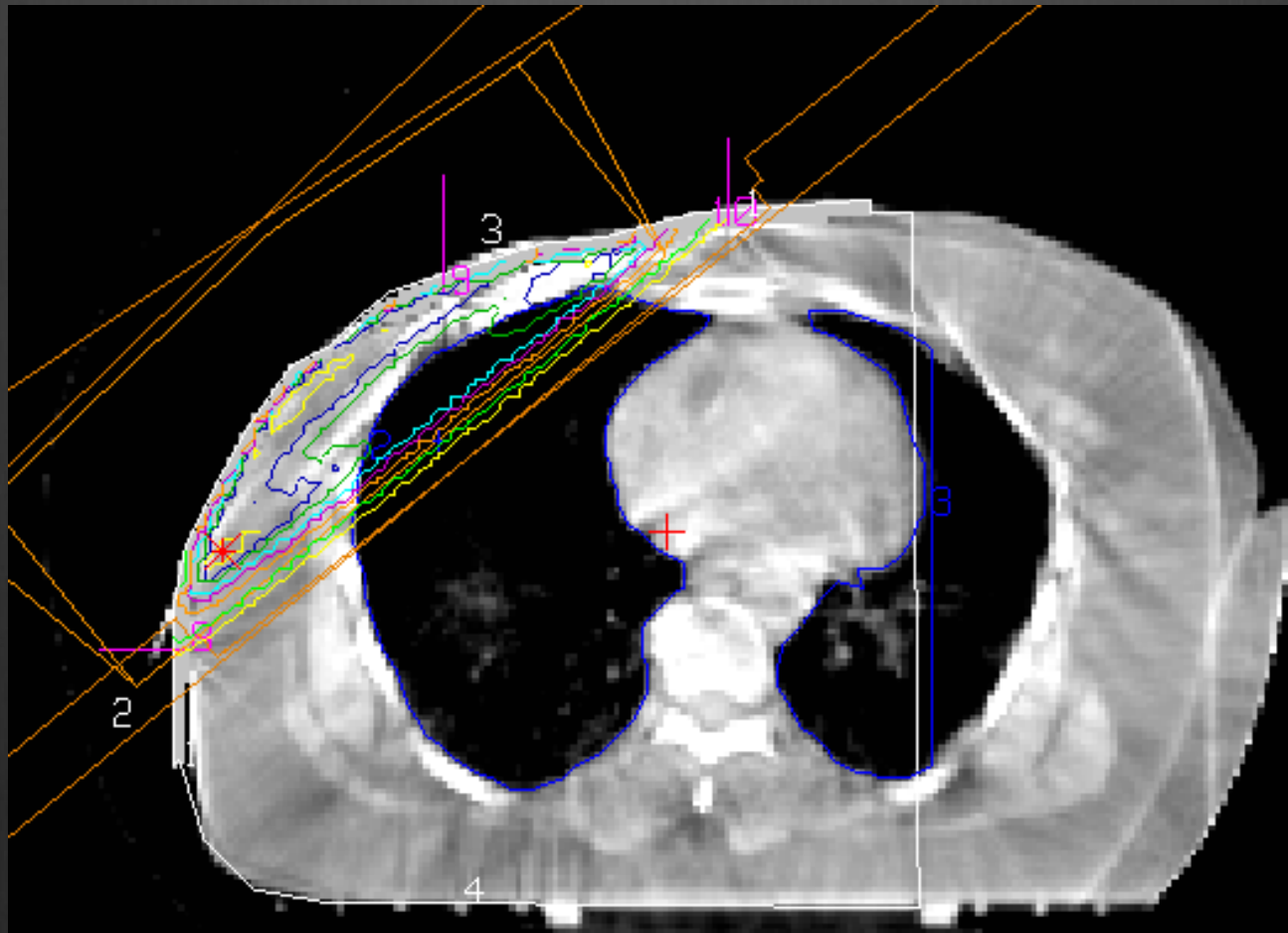
Left Shallow



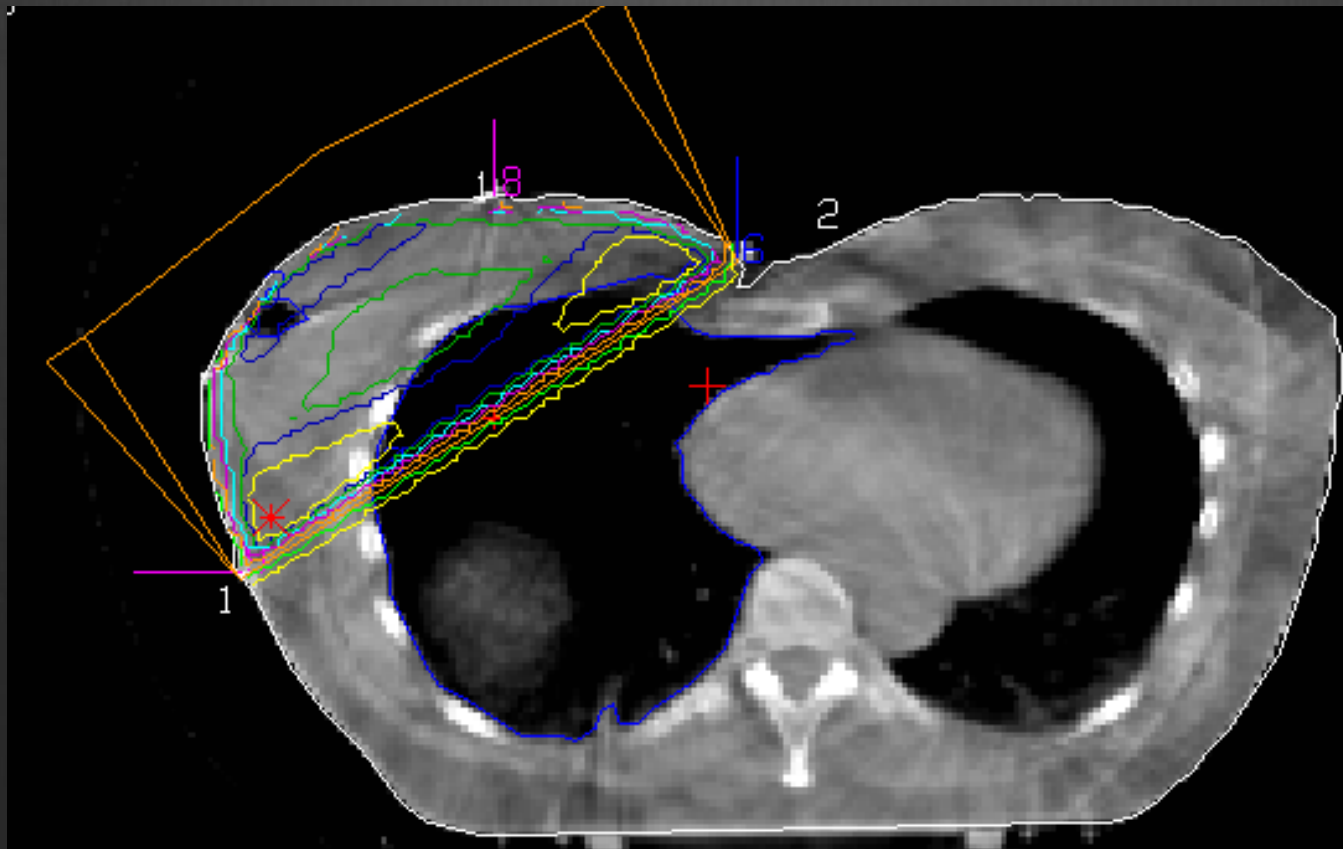
Left Steep



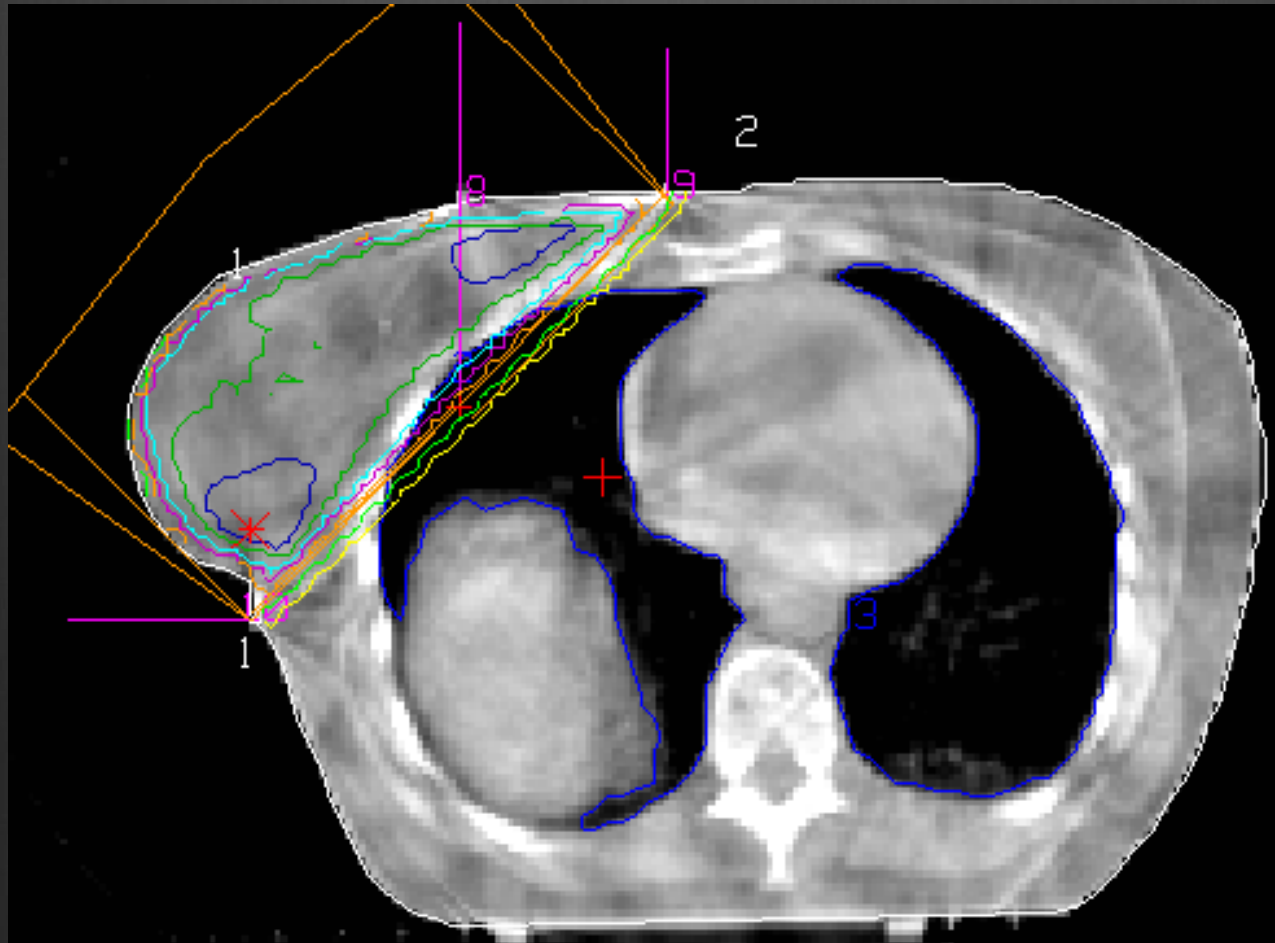
Right Mx



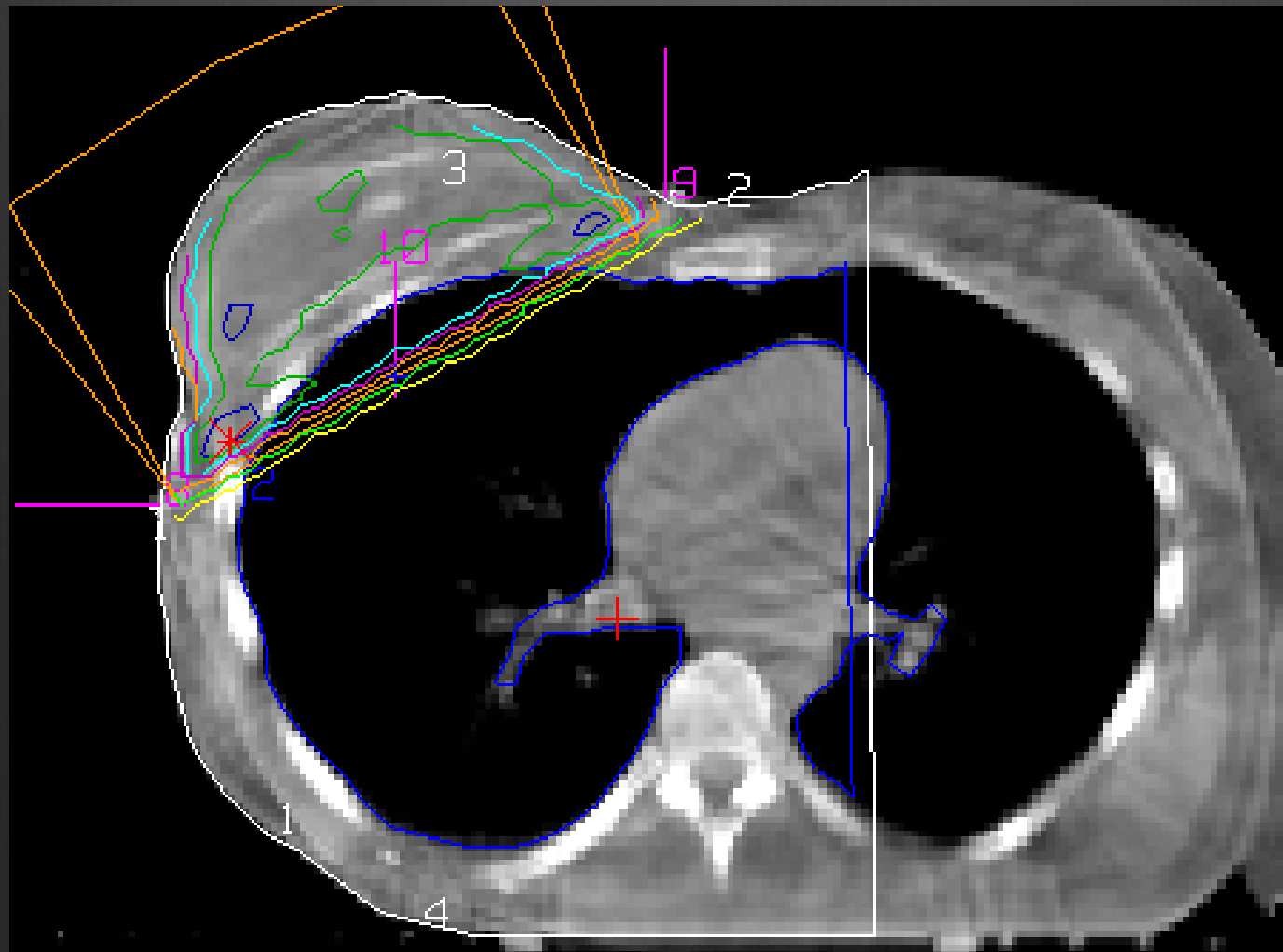
Right Wide



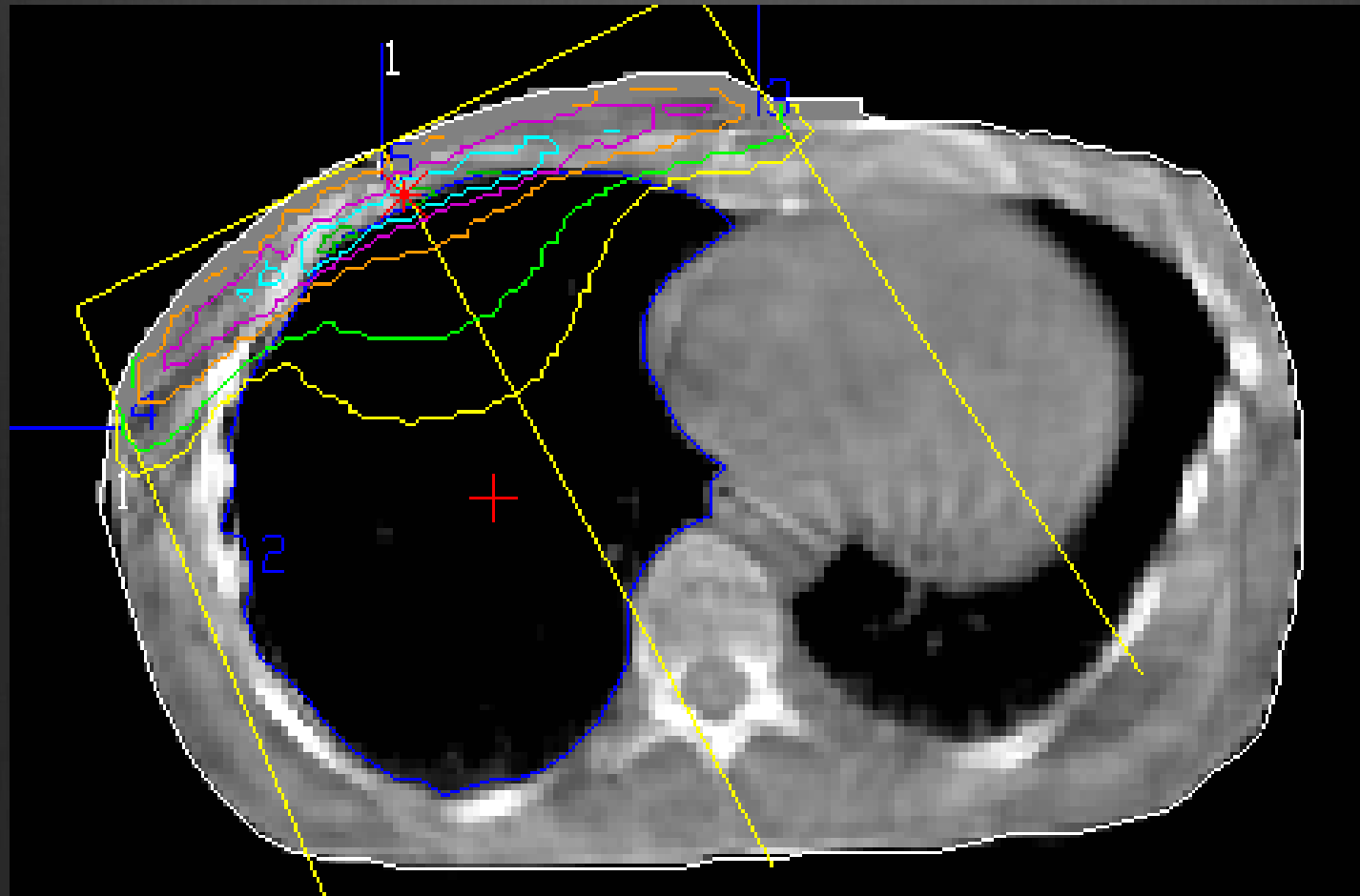
Right Drift



Right Implant



Right e-



History

- ⊕ Excess cardiac risk well recognised for breast RT by early 90's with >20 yr FU of pts treated in 60's, 70's.
- ⊕ Increased for left breast cancer particularly.

Breast RT Outcome

- ⊗ SEER Database 1990 – 1999
 - ⊗ Female breast cancer pts who underwent lumpectomy and adjuvant RT grouped by laterality
 - ⊗ Primary outcome: rate of cardiac-related mortality
 - ⊗ 66,687 subjects
 - ⊗ Cardiac related mortality

	5 yr	10 yr	15 yr
Right	1.6	4.4	8
Left	1.5	4.3	7.7

Pericardium

- ⊕ Late fibrosis and constrictive effect
- ⊕ Pericardial effusion
- ⊕ In a 15 yr surgical series of 36 pts requiring pericardectomy, 8% were due to radiotherapy

Coronary Arteries

- ⊗ Risk of MI 12.9% at 30 yrs post RT to mediastinum (Aleman. 2007)
- ⊗ LAD most at risk in left breast RT

Myocardium

- ⊗ Effect probably mediated by microvascular (capillary) endothelial proliferation
- ⊗ LV systolic dysfunction
 - ⊗ Global longitudinal strain – reduction common after mediastinal RT
 - ⊗ Can be abnormal in presence of normal LVEF
- ⊗ Increased fibrosis noted in myocardium of pts treated for left breast cancer on ultrasound tissue characterisation immediately after completion of RT.
- ⊗ High sensitivity troponin T rise after cardiac RT exposure

Valvular Disease

- ⊗ Affects aortic and mitral valves most
 - ⊗ Stenosis or incompetence
- ⊗ Increase in risk rises significantly above doses of 30 Gy
- ⊗ Risk factor 3.1 for doses 31 – 35 Gy
- ⊗ Risk factor 11.8 for doses > 40 Gy

Paediatric

- ⊕ Excess cardiac mortality in paediatric pts treated with RT with heart radiation dose (HRD) is well recognised.
- ⊕ Cohort Study of 3162 5-year survivors of childhood cancer
 - ⊕ Cardiac disease ≥ 3 evaluated
 - ⊕ Risk increased by factor of 60.4 in pts with HRD ≥ 30 Gy

Hodgkins Lymphoma

- ⊗ Retrospective cohort study of 2524 Dutch pts diagnosed with HL at < 51 yrs age treated between 1965 – 1995 and surviving 5 yrs from diagnosis.
- ⊗ Highest risks of cardiovascular events seen in pts treated when younger than 25.
- ⊗ At 35 yrs post Rx there was a 4 -6 fold increase in incidence of coronary heart disease and congestive heart failure.
- ⊗ 40 year cumulative incidence of CVD was 50%
- ⊗ Effects of mediastinal RT, anthracycline chemo and smoking were additive

Minimising Risk

- ⊕ Registry study of 2553 pts > 65 yrs old treated with radical RT for oesophageal cancer.
- ⊕ Use of IMRT associated with lower cardiac mortality than 3D RT.
 - ⊕ HR 0.18
- ⊕ Increased risk of heart disease related death detected as early as 8 months post RT

Cancer. 2016 Mar 15;122(6):917-28

J Gastrointest Oncol. 2015 Oct;6(5):516-23.

Respiratory Control

- ⊗ Deep Inspiration Breath Hold in Hodgkins RT
 - ⊗ Plans calculated for 22 pts for 3DCRT or IMRT with DIBH or FB.
- ⊗ DIBH reduced the estimated dose to heart and lungs regardless of delivery technique
 - ⊗ IMRT increased dose to breast tissue

Respiratory Control

- ⊗ Active breathing Coordinator in left breast cancer RT
 - ⊗ ABC significantly reduced mean heart dose compared to free breathing
 - ⊗ Median values of reduction 1.7 Gy (62%)
 - ⊗ Prescription 50.4 Gy
- ⊗ Aim for controlled breath hold of 20 – 25 seconds

Risk Prediction

- ⊕ Balance risk of increased mortality from radiation cardiac disease against survival benefit from intervention.
- ⊕ NTCP Normal Tissue Complication Probability
 - ⊕ $V_{25} < 10\%$ = 1% risk at 15 yrs

Stents, Pacemakers & ICD's

- ⊕ Coronary artery stents have no increased failure rate after thoracic EBRT
- ⊕ Pacemakers and ICD's may be damaged by ionising radiation

New Risks

- ⊗ SABR / SBRT
 - ⊗ Irradiation of mediastinal structures may cause fatal morbidities
 - ⊗ Great vessel rupture
 - ⊗ Cardiac dose associated with radiation pneumonitis

Other Risks

- ⊗ Systemic therapy
 - ⊗ Anthracyclines
 - ⊗ Trastuzemab (Herceptin)

- ⊗ Metabolic Syndrome
 - ⊗ Cranial RT
 - ⊗ IGF-1

- ⊗ Smoking, obesity, hyperlipidaemia, alcohol

Questions