Cardiac Complications in the Oncologic Patient

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Objectives

- To review chemotherapy and radiation induced cardiotoxicities
- To review other complications in the oncologic patient
  - Cardiac effects in myelodysplastic patients
  - Amyloidosis

Background

- Chemotherapy and RT cause cardiac damage
- Effects of cardiotoxicity more evident as patients age
- Early cardiotoxicity can be occult
  - Radiologist may be the first to dx
  - Early recognition can prompt therapy and prevent progressive damage

Chemotherapy induced cardiotoxicity

- Anthracyclines
  - Doxorubicin, Epirubicin, Idarubicin
- Alkylating Agents
- Antimetabolites
- Dose dependent decline in EF which may lead to CHF
- Induction of free radicals
  - Damage cell membrane of myocardiocites → cell death and fibrosis
  - Inhibit DNA repair enzymes, block messages that control myocardial contractility

3 distinct phases of CHF

- Acute
  - Rare (<1%)
  - Within hours to days of drug administration
  - Transient and reversible decline in LVEF
- Early
  - Uncommon (1.6-2.1%) of patients
  - Within a 1 year of drug administration
  - Risk is dose dependent
- Late
  - Most common (1.6-5%)
  - Can occur > 1 year of therapy
  - Can develop as late as 20 years after drug administration
Screening
- Cardiotoxicity - limiting factor in chemotherapy dosing
- Goal: detect a subclinical decline in LVEF
- Adjust chemotherapy regimen
- Guidelines: baseline US of heart for LVEF measurement and repeat study at some time interval
- Limitations of US:
  - Acoustic window/poor echo windows
  - High interobserver variability in LVEF calculation
  - Assumes symmetry in the left ventricle
  - Altered architecture/contraction in damaged heart

Cardiac MR imaging
- Standard reference for LVEF calculation
- Limited by long study time and cost

Modified Simpson method
- End-diastole
- End-systole

2D echocardiogram EF measurement

63 y/o female w/ lymphoma  24 y/o male w/ stage 4 gastric CA

Radiation induced cardiotoxicity
Radiation induced cardiotoxicity

- Radiation can affect all structures of the heart
  - Pericardial disease
  - CAD
  - Valvular disease
- Common cohorts
  - Hodgkin lymphoma
  - Breast cancer
  - Lung cancer
  - Esophageal cancer
  - Seminoma

Radiation induced pericardial disease

- Most commonly affected structure in the heart from RT
- Up to 70% of patients treated with RT develop pericardial dz
- Deposition of collagen and fibrin in the pericardium
- Acute or chronic pericarditis
  - Pericardial effusion
  - Pericardial tamponade
  - Constrictive pericarditis


Constrictive pericarditis

Constrictive pericarditis – signs

- Pericardial calcification
- Atrial invagination (pericardial effusion)
- Septal bounce
  - Leftward shift of the interventricular septum during diastole
  - Increased ventricular interdependence
    - Increased volume in one ventricle causes a decreased volume in the other ventricle
    - Accentuated with inhalation
- Treatment: Pericardial stripping

Constrictive pericarditis – calcific

Constrictive pericarditis – atrial invagination

Normal 4ch view
Constrictive pericarditis – septal bounce

Radiation induced CAD

- Patients treated with RT, higher cardiac mortality
- Mechanism of RT damage
  - Fibrous intimal proliferation → Vessel narrowing
  - Thinning of the medial vessel wall and extensive adventitial fibrosis in addition to intimal plaque

Radiation induced CAD

- Preferential proximal vessel involvement

Radiation induced CAD

- 45 yo m w/ Hodgkins lymphoma, mediastinal RT

Radiation induced CAD

- 36 yo m w/ rhabdomyosarcoma, mediastinal RT

Radiation induced CAD

- Radiation causes fibrous thickening of the valvular endocardium
- Damage up to 81% (15-33yo)
- Most are asymptomatic
  - Radiologist may be the first to suggest valvular disease
- Left sided valves more commonly affected
  - Possibly due to higher LV pressure

Radiation induced valvular disease

- **Pre Radiation**
- **Post Radiation**

50 yo m w/ Hodgkins lymphoma, mediastinal RT

60 yo m w/ Hodgkins lymphoma, mediastinal RT

Myelodysplastic syndromes

- Common complications
  - Anemia
    - Increased cardiac output to compensate for impaired tissue oxygenation
    - Cardiac remodeling
  - Iron overload
    - Repeated supportive RBC transfusions

Anemia induced high output heart failure

Iron overload

- Excess non transferrin bound iron deposits in plasma
- Uncontrolled iron loading of organs
  - Liver
  - Heart
- Transfused MDS patients at higher risk than non-transfused patients
- Cardiac MRI is more accurate than echocardiogram

Iron overload and MRI

- Iron causes local distortion in the magnetic field and relaxation of the spins
- Shortening of the transverse relation time ($T_2^*$)
- This effect causes loss of signal in the affected tissue
  - Effect is concentration dependent
- $T_2^*$
  - Gradient sequence
    - More susceptibility artifact since there is no rephasing pulse (spin-echo)
Iron overload and MRI

21 yo f w/ Ewing sarcoma
64 yo m w/ Leukemia

T2* = 46 msec
T2* = 14 msec
(Normal T2* >20 msec)

Amyloidosis

- Amyloid - insoluble extracellular protein
- Primary Amyloidosis
  - Monoclonal plasma cell dyscrasias (multiple myeloma)
- Secondary Amyloidosis
  - Due to tissue destruction and inflammatory process
    - TB
    - Rheumatoid Arthritis
    - Crohn's disease
    - Ankylosing Spondylitis
    - Sjogren syndrome
    - Dermatomyositis
- Most common cause of restrictive cardiomyopathy

Amyloidosis - cardiac MRI findings

- Patchy or subendocardial delayed enhancement
- LV wall thickening
- Reduced systolic function
- Restriction of diastolic filling
- Disproportionate atrial enlargement

Cardiac amyloidosis

59 yo m w/ primary systemic amyloidosis

Conclusion

- Reviewed chemotherapy and radiation induced cardiotoxicities
- Complications in the oncologic patient
  - Cardiac effects in myelodysplastic patient
  - Amyloidosis