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# Understanding the Diagnostic and Prognostic Role of Imaging in the Evaluation of an Anterior Mediastinal Mass

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# Agenda

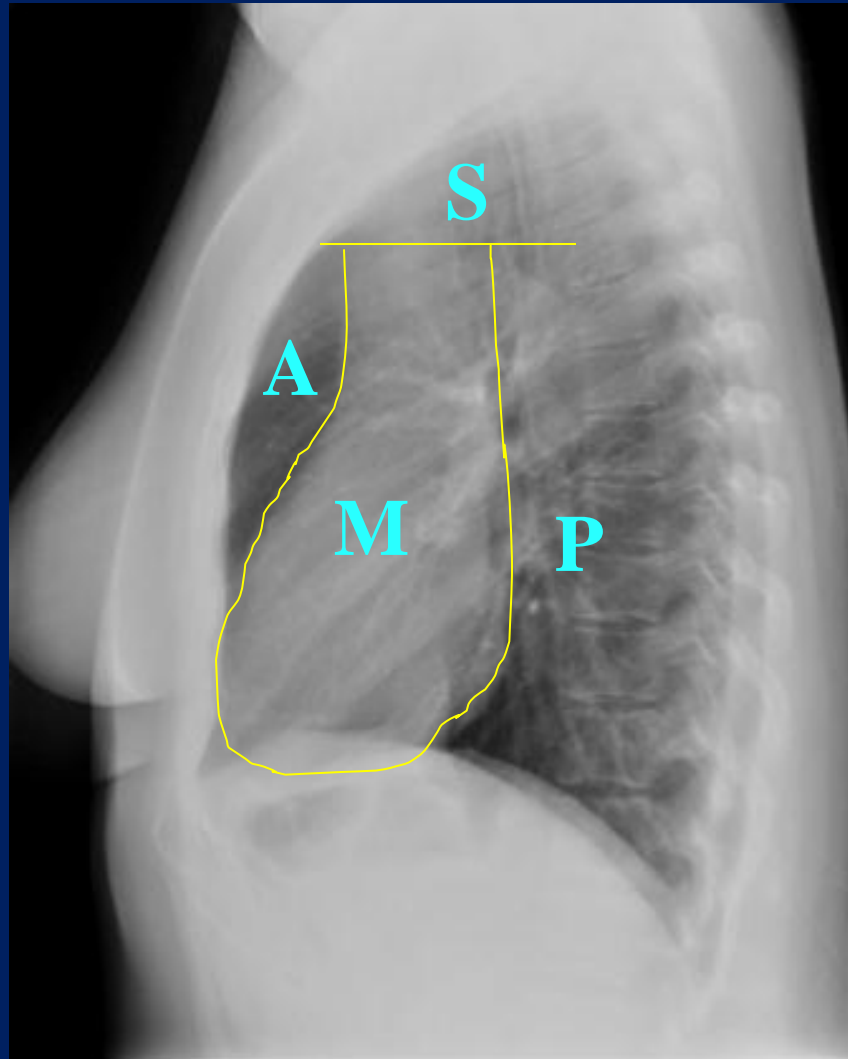
- Mediastinum
  - Menu of tests
  - Anatomy
  - Normal and abnormal anterior mediastinal structures



# Menu of Tests for Imaging the Mediastinum

- Common studies
  - Chest radiograph
  - Chest CT
- Lesser used studies
  - Chest MR
  - PET scan
  - Other nuclear medicine studies: MIBG, thyroid

# Anatomy of the Mediastinum





# Anterior Mediastinum

- Normal contents
  - Thymus
  - Lymph nodes
  - Connective tissue
  - Nerves
  - Germ cells
- Abnormal contents (the 3 T's)
  - Thymic tumor
  - “Terrible” Lymphoma
  - Teratoma (germ cell tumor)
- Thyroid is not considered anterior mediastinal



# Agenda

- Mediastinum
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  - Anatomy
  - Normal and abnormal anterior mediastinal structures
- Patient presentation
  - Initial presentation
  - Rationale behind imaging
  - Review imaging
  - Consider differential diagnoses



# Patient XY

## Initial Presentation

- XY is a 25 y/o female with h/o R foot synovial sarcoma (< 5 cm) s/p resection and radiation 10 years prior who presents for regularly scheduled follow-up
- Last seen two years prior at which time she was asymptomatic, physical exam was normal, and CXR was normal
- Denies any symptoms; no fevers, chills, night sweats, weight loss, dysphagia, cough, or dyspnea
- Physical exam reveals no focal findings
- XY needs imaging for metastatic surveillance...



# Menu of Tests for Follow-up of Malignant MSK Tumors

1. Chest radiograph
2. CT chest w/o contrast
3. CT chest w/ contrast
4. CT chest w/ and w/o contrast
5. FDG-PET/CT whole body





# Which imaging modality do you choose?

1. Chest radiograph
2. CT chest w/o contrast
3. CT chest w/ contrast
4. CT chest w/ and w/o contrast
5. FDG-PET/CT whole body



# ACR Appropriateness Criteria

**Clinical Condition:**

**Follow-up of Malignant or Aggressive Musculoskeletal Tumors**

**Variant 1:**

**Lower-risk patient (low grade). Evaluation for metastatic disease to the lung from musculoskeletal primary.**

Modality for Follow-Up Examination			
CT chest without contrast	9		⊗ ⊗ ⊗
FDG-PET/CT whole body	4	Can be a useful problem-solving tool if another study is equivocal.	⊗ ⊗ ⊗ ⊗
X-ray chest	3		⊗
CT chest with contrast	1		⊗ ⊗ ⊗
CT chest without and with contrast	1		⊗ ⊗ ⊗

Duration of Follow-Up			
10 years	9	After 5 years, frequency can decrease to every 6-12 months.	Varies
5 years	2		Varies
<b>Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</b>			<b>*Relative Radiation Level</b>



# Patient XY

## Initial screening modality

- Mrs. T received a CXR...why? Must consider the following
  - Radiation dose
  - Cost considerations
  - 10 years s/p treatment w/ no abnormal follow-up visits to date
  - Currently asymptomatic

# Patient XY

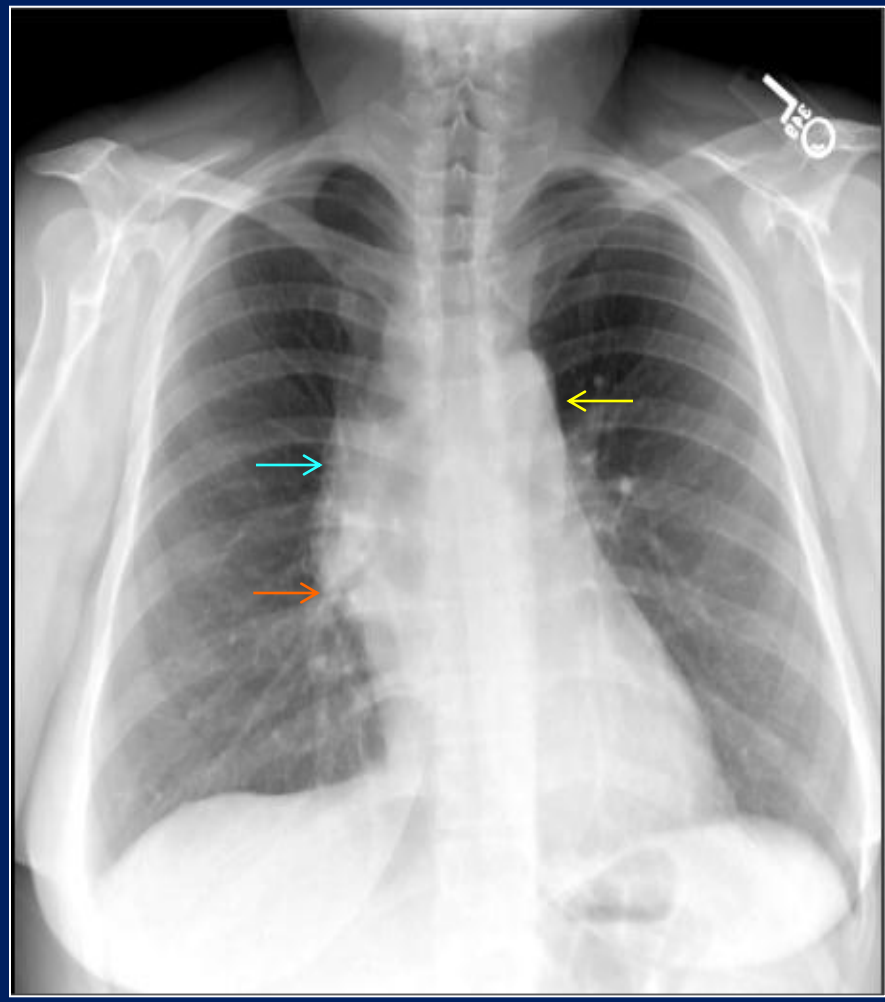
## Prior CXR in 2010





# Patient XY

## Current CXR in April 2012



- Significant **widening of the mediastinum** that projects mostly over the R hilar region (w/ the **hilum overlay sign**)
- Noticeable **fullness** of the AP window



- Large **anterior mediastinal mass** that obliterates the retrosternal space and bulges into the middle mediastinum
- Slight **tracheal displacement** posteriorly



# Summary of CXR Findings

- Frontal
  - Great expansion of the mediastinum that projects mostly over the R hilar region (w/ the hilum overlay sign)
  - Fullness of the AP window
- Lateral
  - Large anterior mediastinal mass that obliterates the retrosternal space and bulges into the middle mediastinum
  - Slight tracheal displacement posteriorly

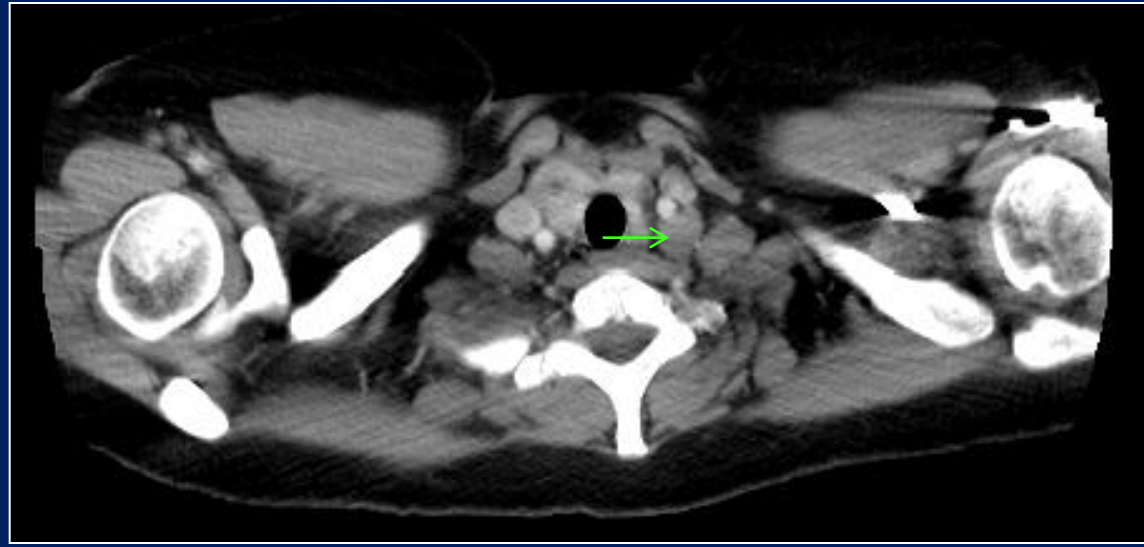


# Differential Diagnoses Based on Chest Radiograph

- What is the differential at this point?
  - Metastases from MSK primary (given patient h/o sarcoma)
  - Lymphoma
  - Thymic tumor
  - Germ cell tumor
- What is the next step?
  - CT chest

# Patient XY

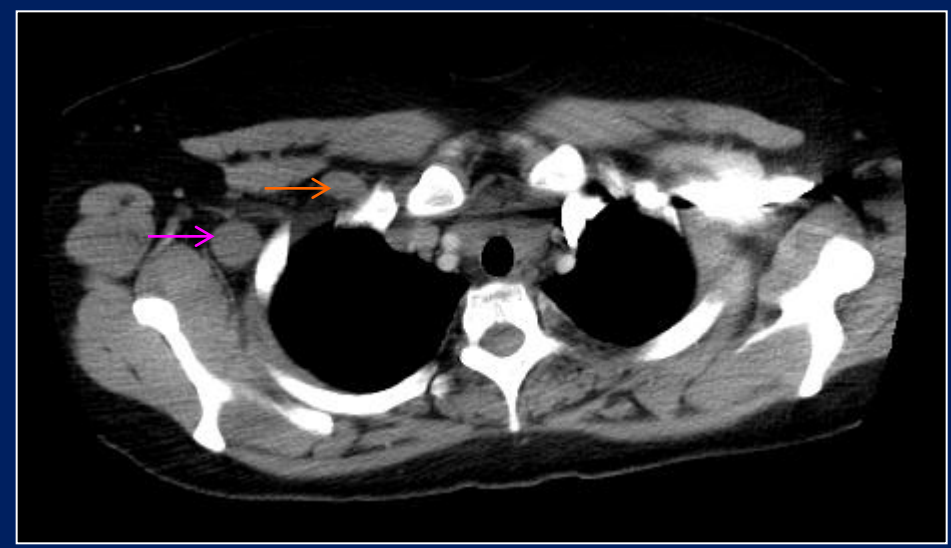
## CT Chest in April 2012: Images #1 and #2



- Enlarged left supraclavicular lymph node measuring 1.91 x 1.88 cm

C+ axial CT

- Enlarged right supraclavicular lymph node measuring 1.41 x 1.68 cm
- Enlarged right axillary lymph node measuring 1.94 x 2.12 cm

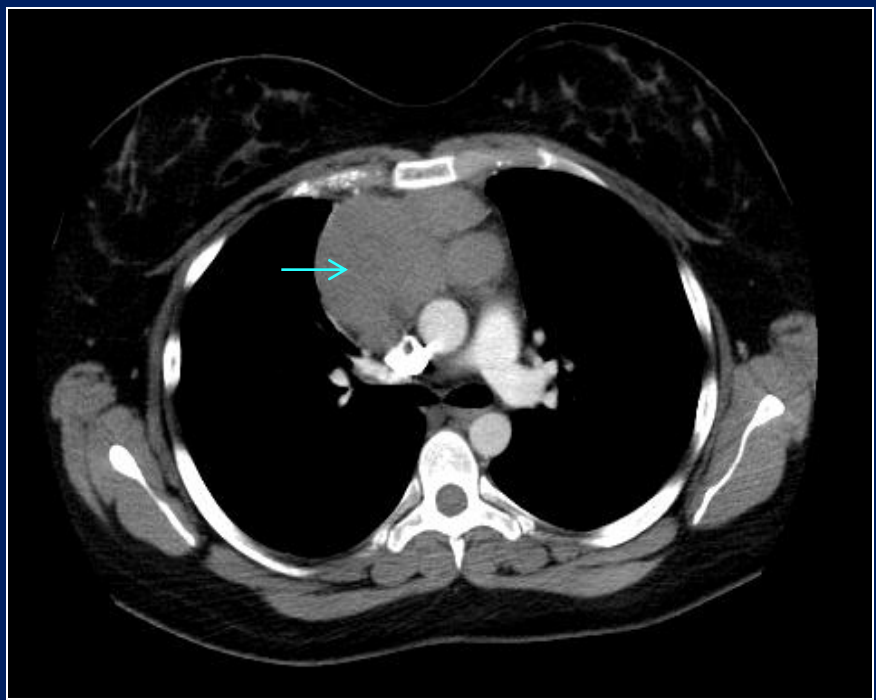


C+ axial CT



# Patient XY

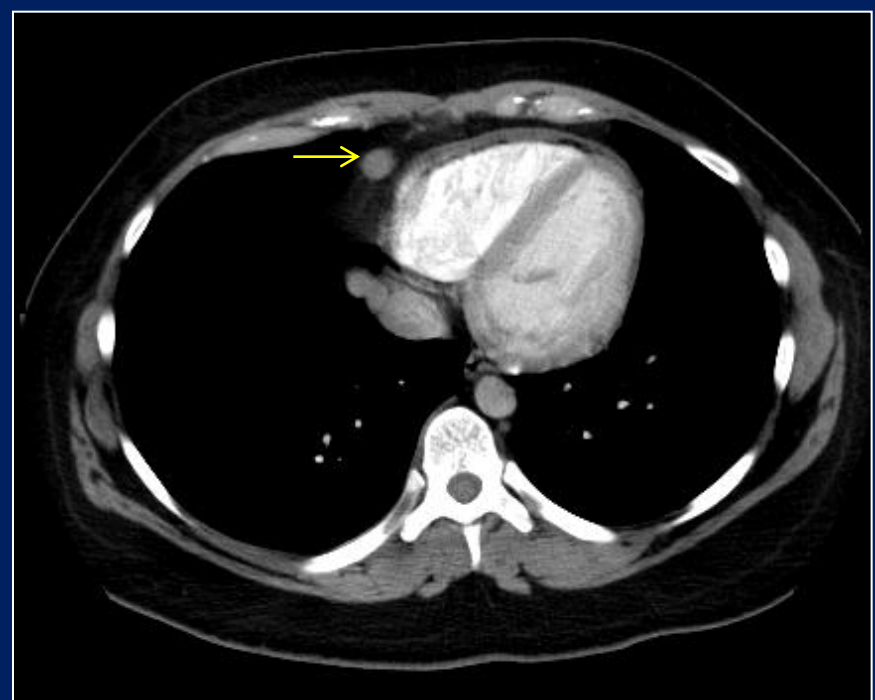
## CT Chest in April 2012: Images #3 and #4



C+ axial CT

- Large prevascular nodal mass measuring lymph node measuring 6.02 x 8.61 cm

- Enlarged epicardial lymph node measuring 1.16 x 1.27 cm

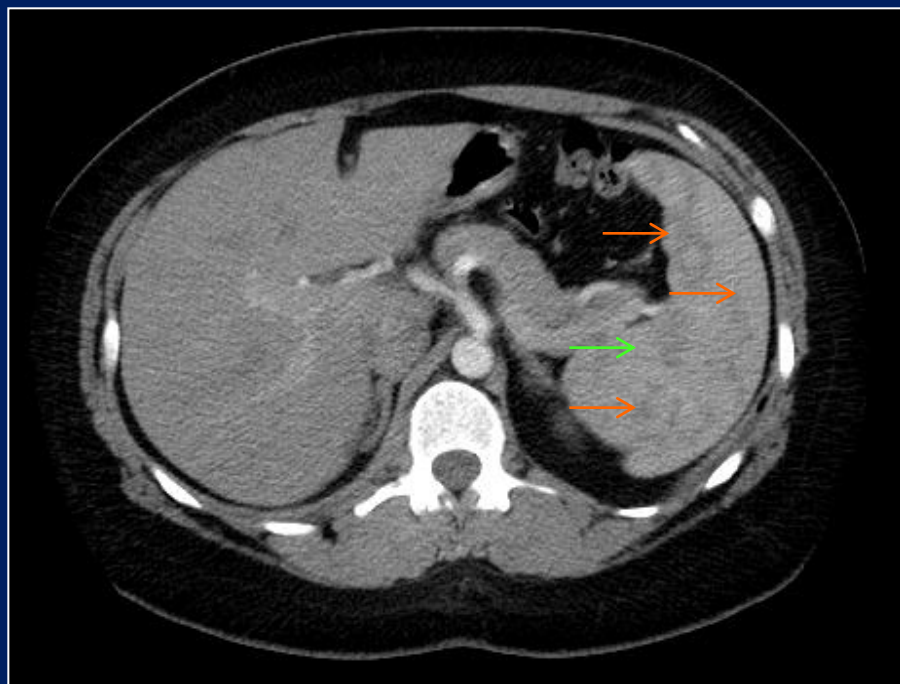


C+ axial CT



# Patient XY

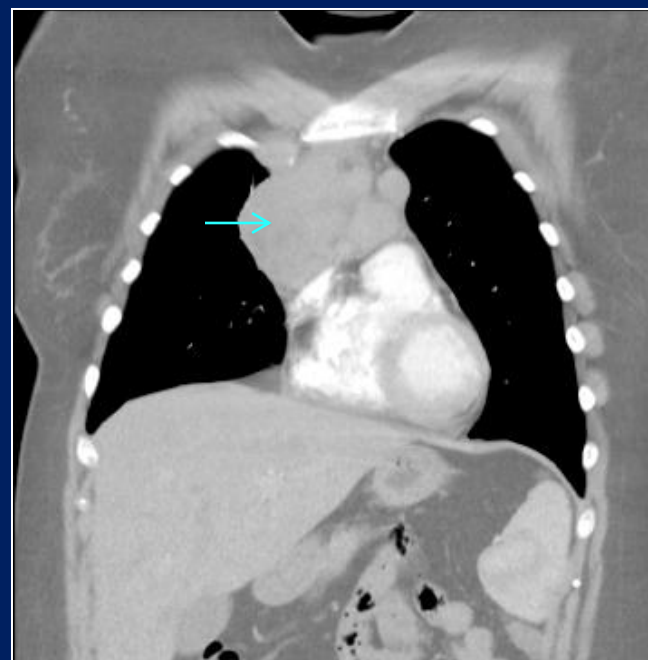
## CT Chest in April 2012: Images #5 and #6



C+ axial CT

- Large anterior mediastinal mass seen again, this time on coronal reconstruction view

- Enlarged spleen measuring 14.47 cm along its longest axis
- Heterogeneously enhancing spleen due early arterial phase acquisition



C+ coronal CT



# Differential Diagnoses Based on CT Findings

- NOT likely a metastases from MSK primary
  - Primary site of metastases is lung
  - Expect abdominal node involvement if spread is from prior site (R foot)
- NOT likely a germ cell tumor
  - Expect heterogeneous attenuation w/ fat to calcium densities
- NOT likely a thymoma
  - Benign masses are usually small, well-defined homogenous masses
  - Malignant masses appear w/ heterogeneous attenuation w/ fat to calcium densities
- MOST likely a lymphoma
  - Large anterosuperior mediastinal mass with homogenous attenuation
  - Enlarged nodes in adjacent lymph node chains



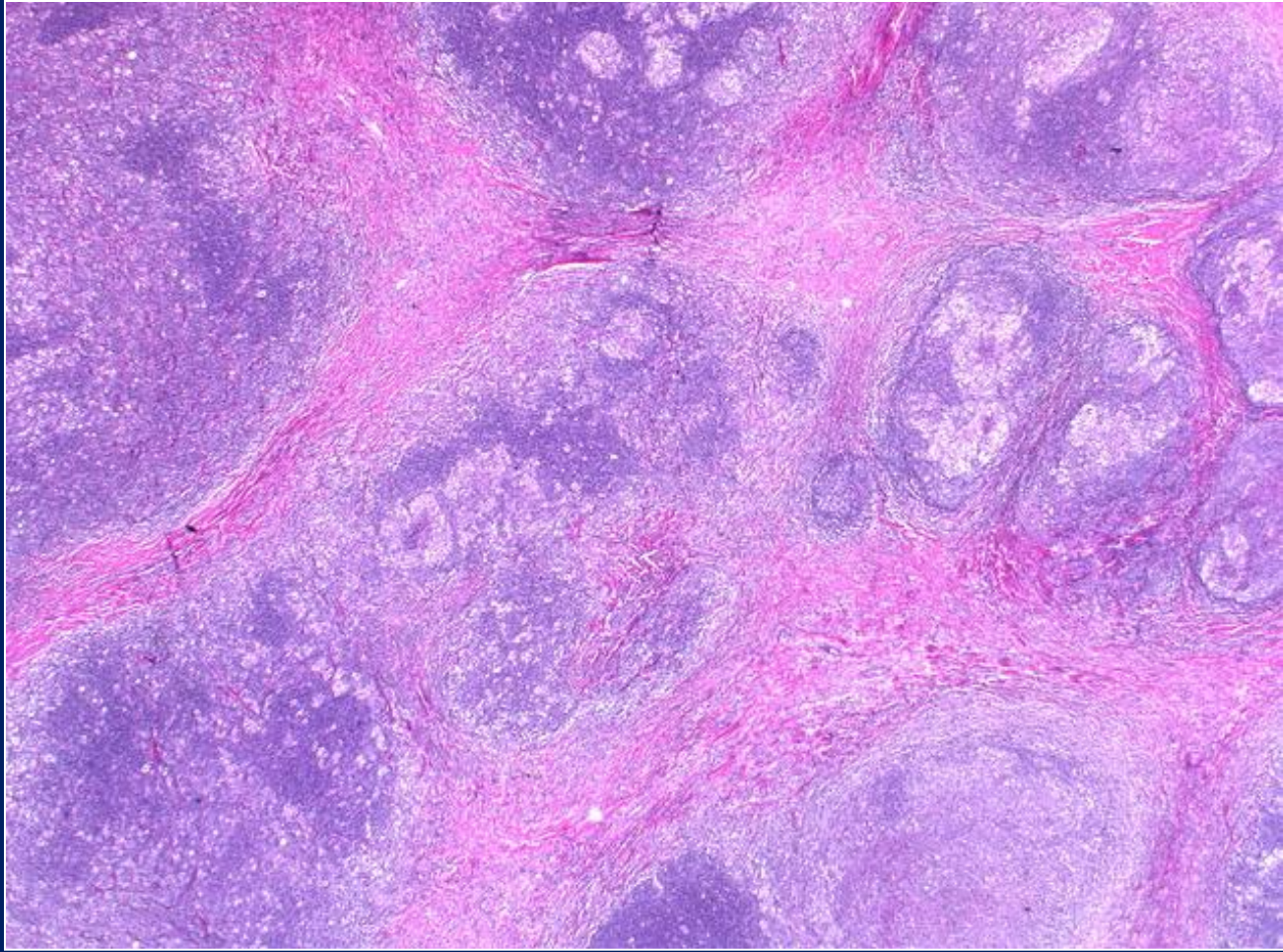
# Patient XY

## Biopsy procedure

- Patient XY underwent a median sternotomy procedure in order to obtain tissue for definitive diagnosis
- An enlarged lymph node was delivered and sent to pathology for examination

# Patient XY

## Biopsy Results



Classical Hodgkin Lymphoma: Nodular Sclerosis type



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  - Review imaging
  - Consider differential diagnoses
- Hodgkin lymphoma
  - Basics of Hodgkin lymphoma
  - Staging in Hodgkin lymphoma
  - Menu of tests for staging

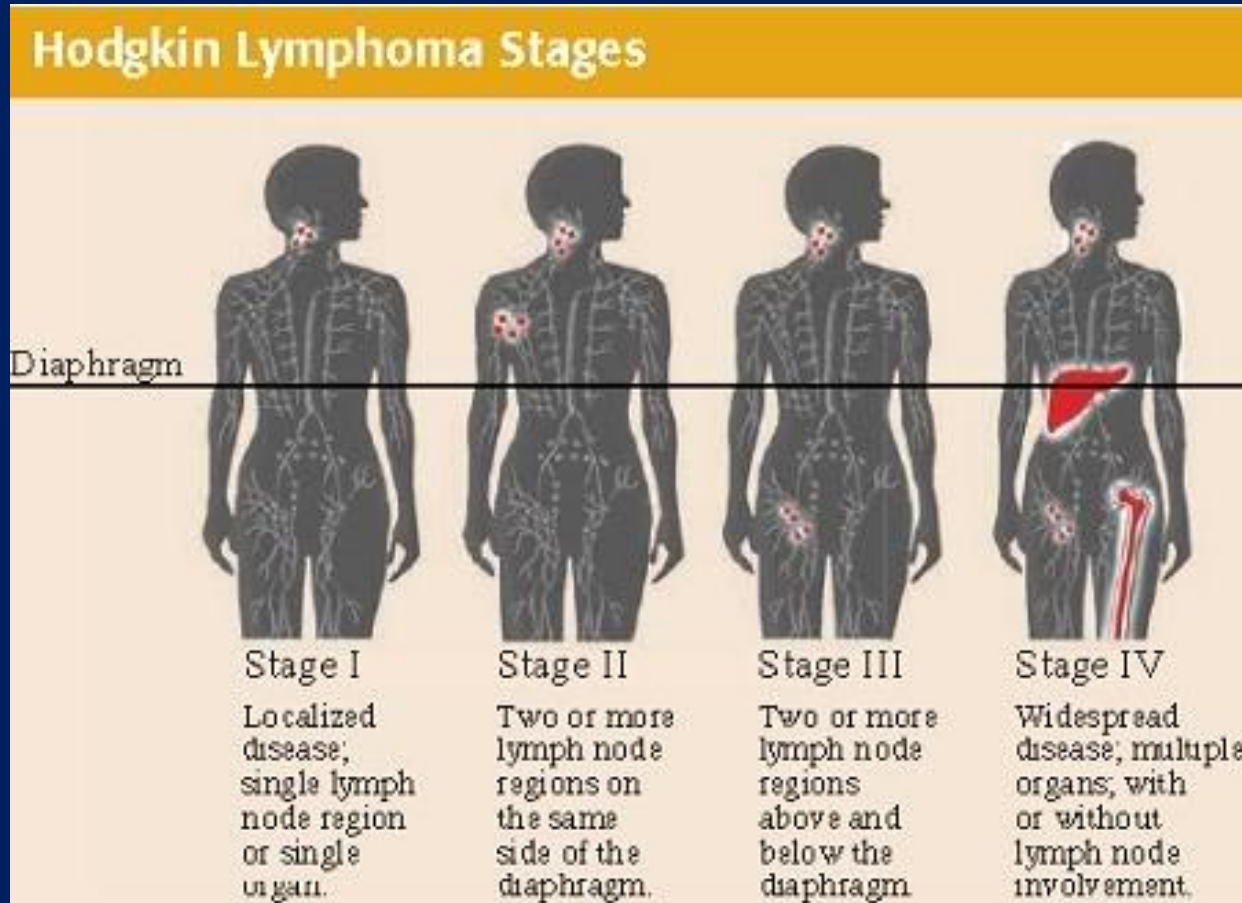


# Hodgkin Lymphoma

- B cell lymphoma
  - Classical HL
    - Nodular sclerosis (70%)
    - Mixed cellularity (20-25%)
    - Lymphocyte rich (5%)
    - Lymphocyte depleted (1%)
  - Nodular lymphocyte predominant HL
- 10% of all lymphomas;  
0.6% of all cancers
- Bimodal age distribution
  - Peaks at 20 and 65 years of age
- Risk factors
  - EBV infection, autoimmune disorders, immunodeficiency
- Most often presents with painless cervical adenopathy
- Pathologically defined by presence of Reed-Sternberg cells in an inflammatory background
- Treatment with chemotherapy +/- radiation therapy depending on stage of lymphoma



# Ann Arbor Staging System w/ Cotswolds Modifications





# Menu of Tests for Staging Hodgkin Lymphoma

- Diagnosis
  - Chest radiograph
  - CT chest
- Staging
  - PET/CT



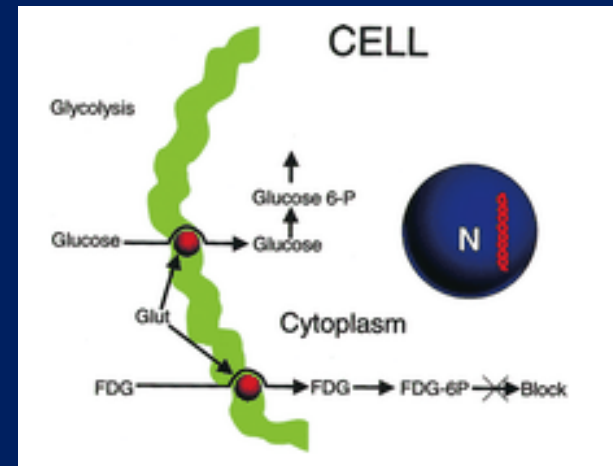
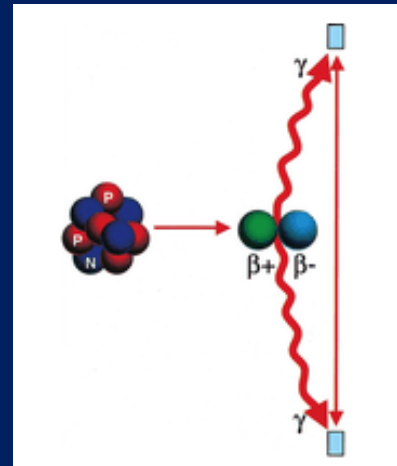
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  - Menu of tests for staging
- **PET/CT**
  - **Basics of PET/CT**
  - **Review patient's PET/CT images and stage our patient**

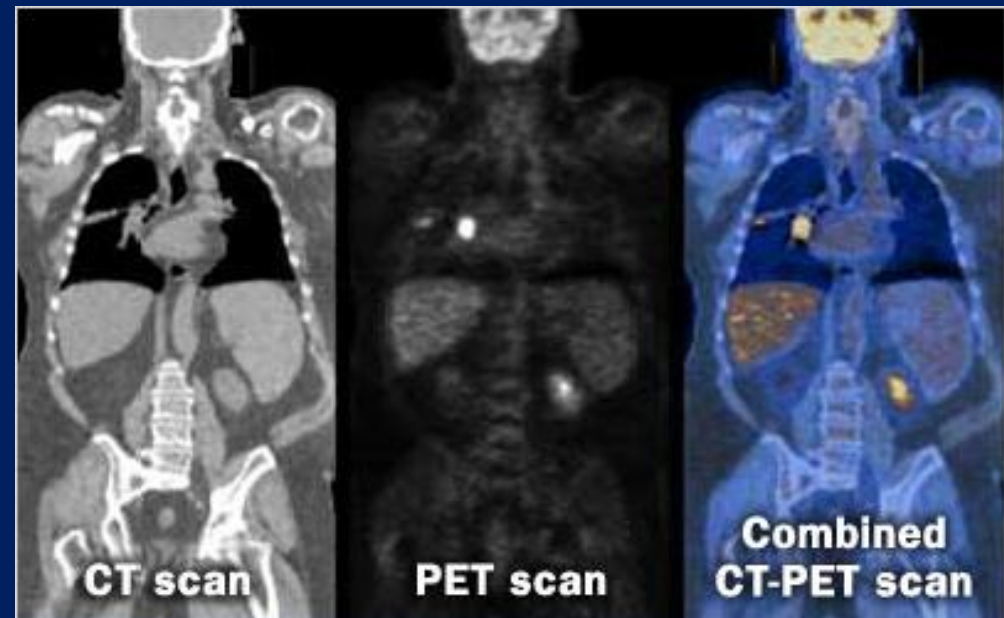


# PET/CT Overview

- Nuclear imaging that detects gamma rays emitted by a positron-emitting radionuclide (tracer such as FDG)
- With FDG, an analogue of glucose, PET measures tissue metabolic activity
  - Cancers use more glucose than most normal tissues
- Integral for cancer staging and monitoring treatment response
  - Other uses in neurology (dementia, epilepsy) and cardiac perfusion studies
- Cannot be performed in pregnant patients, relative contraindication in renal failure patients
- Limited by cost, ionizing radiation, availability of radiotracers



[radiographics.org](http://radiographics.org)



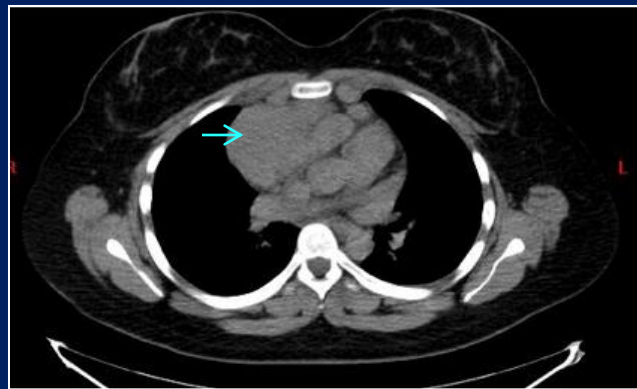


# Patient XY

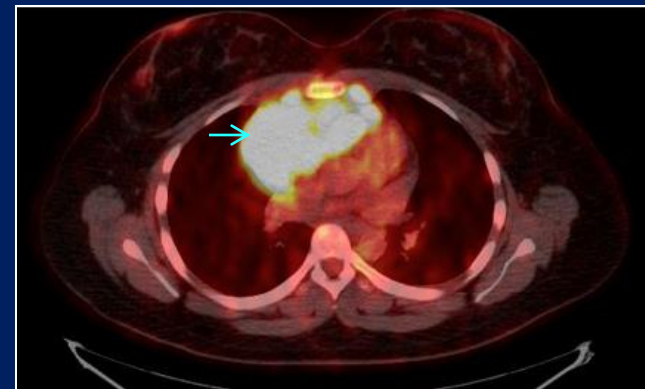
## Final PET/CT in May 2012



PET Scan



CT Scan



Integrated PET/CT

- Extensive FDG avidity observed in the **left supraclavicular**, **right subpectoral**, **right axillary**, **anterior mediastial**, **epicardial**, and **cardiophrenic** stations.
- FDG-avid **right thyroid nodule**



# Patient XY

## Staging

**Hodgkin Lymphoma Stages**

Diaphragm

Stage I	Stage II	Stage III	Stage IV
Localized disease; single lymph node region or single organ.	Two or more lymph node regions on the same side of the diaphragm.	Two or more lymph node regions above and below the diaphragm.	Widespread disease; multiple organs; with or without lymph node involvement.



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- PET/CT
  - Basics of PET/CT
  - Review patient's PET/CT images and stage our patient
- Clinical course
  - Treatment
  - Follow-up

# Patient XY

## ACR Recommended Treatment

<b>Clinical Condition:</b>	Hodgkin's Lymphoma — Favorable Prognosis Stage I and II	
<b>Variant 1:</b>	25-year-old woman with stage IIA NSHL with left supraclavicular and mediastinal (3 cm in widest diameter) involvement; normal ESR.	
Treatment	Rating	Comments
Chemotherapy and IFRT	8	
Chemotherapy alone	4	
<b>Type of Chemotherapy</b>		
ABVD	9	
Stanford V	7	Includes IFRT. Eight-week course.
<b>Duration of ABVD (If Chemotherapy Given Alone)</b>		Note: Chemotherapy alone is rated 4.
2 cycles	2	
4 cycles	4	
6 cycles	7	
<b>Duration of ABVD (Combined-Modality)</b>		
2 cycles	8	Patient needs to meet all GHSB HD10 eligibility criteria. See text.
4 cycles	8	
6 cycles	5	
<b>Dose of Radiation Therapy (Combined-Modality)</b>		
20 Gy	8	Patient needs to meet all GHSB HD10 eligibility criteria. See text.
30 Gy	6	
30 Gy + 6 Gy boost to mediastinum	3	
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate		



# Patient XY Treatment

- XY underwent 4 cycles of ABVD w/o radiation therapy
  - Evidence suggests benefit of avoiding radiation therapy in younger patients in which ionizing radiation may be more harmful

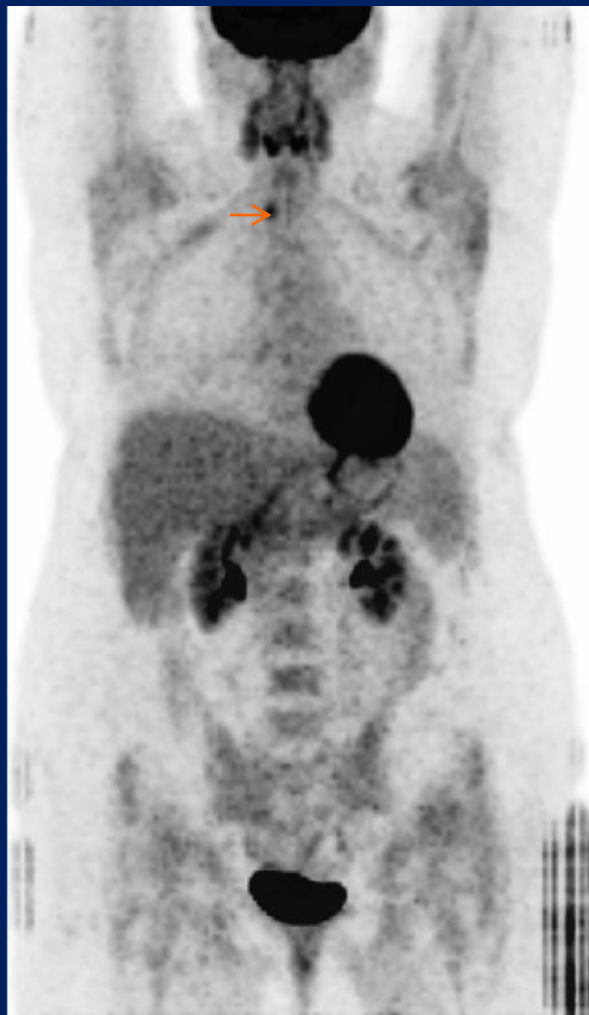






# Patient XY

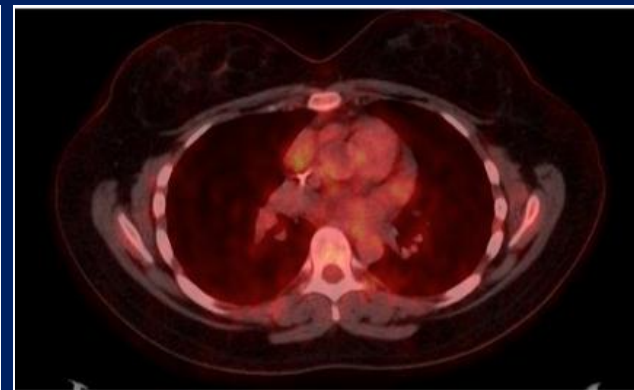
## Final PET/CT in Nov. 2012



PET Scan



CT Scan



Integrated PET/CT

- Complete resolution of FDG-avid areas compared to initial PET/CT in May 2012
- Persistent **FDG-avid right thyroid nodule**, present and unchanged from previous scans

# Patient XY

## PET Scan Comparison Pre- and Post-Treatment



Pre-Treatment PET Scan



Post-Treatment PET Scan



# Patient XY

## Follow-up Plan

**Clinical Condition:**

**Follow-up of Hodgkin's Lymphoma**

**Variant 2:**

**28-year-old female with stage IIBX supradiaphragmatic Hodgkin's lymphoma (ESR 30), treated with ABVD x 6 (residual PET avidity after 2 cycles of ABVD, avidity resolved after 6 cycles of ABVD) followed by IFRT, now 1 month post-treatment.**

Procedure	Rating	Comments
History and physical examination every 2-4 months for 2 years, then every 6 months for 3 years, then yearly	9	
X-ray chest every 6 months for 2 years, then yearly	6	Unless chest CT performed.
CT chest abdomen and pelvis every 6 months for 2 years, then yearly for 3 years	8	
FDG-PET/CT whole body every 6 months for 2 years, then yearly for 3 years	2	
FDG-PET/CT whole body at 6 months – if negative then CT chest abdomen and pelvis every 6 months for 2 years, then yearly for 3 years	5	

- Though the evidence as stated above recommends CT chest, abdomen, and pelvis, there is a move toward reducing radiation dose . Thus use MR as the imaging tool of choice for specific follow-up to certain conditions is becoming increasingly common.



# Patient XY

## Conclusion

- XY has been deemed to be in complete remission as of Nov. 12, 2012
- She is currently doing well and without any symptoms
- She plans on following-up closely with her oncologist
- In the mean time, she is enjoying time with her 9-month old baby boy



# Summary

- Mediastinum
  - Menu of tests to evaluate the mediastinum
  - Normal and abnormal anatomy of the anterior mediastinum
- Patient presentation and initial imaging tests
  - Understanding the rationale behind screening tests and the sequential order in which imaging tests are ordered
  - Generating differentials based on imaging findings
- Subsequent patient course
  - Understanding the basics of Hodgkin lymphoma, especially staging
  - Understanding the basics of PET/CT imaging
  - Importance of PET/CT in staging and monitoring treatment response in Hodgkin lymphoma



# References

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