MRI of Mediastinum, Chest Wall and Pleura in Children

No financial disclosures
Objectives

- To review pediatric chest wall, mediastinal and pleural lesions (and “pseudo-lesions”) according to “radiographic” tissue type (bone, soft tissue, fat)
- To discuss imaging *algorithms* (US vs CT vs MRI)
- To demonstrate the role of MRI in these algorithms
- To tailor imaging to the child’s clinical state
Technique

• **Mediastinum** (25 min)
  - Smallest coil possible, Encoding right-left/ suppress heart / gate
  - Cor STIR
  - Ax B-TFE/TruFISP/ BH FIESTA
  - Cor B-TFE/TruFISP/ BH FIESTA
  - Ax T2 FSE
  - Ax T1 TSE
  - Cor BH VIBE/THRIVE/LAVA
  - Post contrast
    - Ax T1 FS
    - Cor BH VIBE/THRIVE/LAVA

• **Chest wall** (30 min)
  - Thin section / surface coil?
  - Cor or Sag STIR
  - Cor or Sag T1 TSE
  - Ax T2 TSE FS
  - Ax T1 TSE (6 Nex)
  - Post contrast
    - Ax T1 TSE FS (6 Nex)
    - Cor or Sag T1 FS
The Pediatric Chest

- Mediastinum
- Chest wall
- Pleura
Why is MRI Imaging of mediastinum limited to case series, “how I do it” and review articles?

- Limitations
  1. Respiratory / Vascular compromise
  2. Presence of calcification - especially in nodes
  3. Most mediastinal masses in childhood are malignant and require CT to stage pulmonary parenchymal disease
  4. MRI does not replace CT – they are complementary

- Exceptions
  - Posterior mediastinal masses
  - Congenital cysts
  - Suspected vascular malformations

Mediastinum

• Thymus
• Tumors –
  • Lymphoma
  • Adenopathy
  • Neurogenic
• Vascular Malformations
• Cysts
Mediastinum - Normal Thymus

• T1 iso to slightly higher than muscle
• T2 brighter but less than CSF
• Homogeneous, soft, no mass effect
• “Ectopic”
  • MRI diagnostic of “ectopic” thymus
  • Same T1, T2 signal as orthotopic
  • Homogeneous signal
  • Continuity with normal thymus
  • Minimal, if any, mass effect
  • Uniform mild contrast enhancement

Normal thymus - MRI

T1

T2
Normal thymus - MRI

Child referred for mediastinal mass
Normal “ectopic” thymus - MRI

Baby referred for palpable neck mass
Mediastinum

- Thymus
- Tumors –
  - Lymphoma
  - Adenopathy
  - Neurogenic
- Vascular Malformations
- Cysts
Lymphoma

• 50% of all pediatric mediastinal masses
• Initial evaluation usually CT
  • Respiratory, cardiovascular compromise
    • >50% of Hodgkin’s have CXR airway compromise
    • SVC/IVC compromise can result in circulatory collapse
  • MRI as effective as CT in initial evaluation
  • MRI better at anatomic evaluation of subcarinal and hilar regions
• Useful in followup
  • Rebound thymic “rebound” hyperplasia
  • Residual soft tissue density
    • Active disease vs necrosis vs fibrosis
Hodgkin’s at diagnosis

After chemotherapy

4 months after chemoRx therapy ended - “rebound hyperplasia”
Ataxia Telangiectasia

Palpable axillary nodes – Lymphoma
Ataxia Telangiectasia

post treatment necrosis

resolving necrosis 2 months later
Mediastinum

• Thymus
• Tumors
  • Lymphoma (Anterior)
  • Adenopathy (Middle)
  • Neurogenic (Posterior)
• Vascular Malformations
• Cysts
Pattern of tuberculous adenopathy at MR
- central low signal, peripheral enhancement
  ? Calcification ? Increased paramagnetic free radicals

Middle Mediastinal Adenopathy - Castlemans
Mediastinum

• Thymus
• Tumors
  • Lymphoma (Anterior)
  • Adenopathy (Middle)
  • Neurogenic (Posterior)
• Vascular Malformations
• Cysts
Posterior Mediastinum

- Posterior masses – imaging modality of choice for extent of disease
- Neurogenic
  - 90% of all posterior mediastinal masses originate from sympathetic ganglion
    - 60% malignant
- Extent of neurogenic /sympathetic chain masses best imaged by MRI
  - Accurate involvement of chest wall
  - Accurate intraspinal involvement


- Sequestration
  - If clearcut based on pre-natal ultrasound
  - If cystic or ambiguous, CT more useful

Posterior Mediastinum

Thoracic Neuroblastoma
Mediastinum

- Thymus
- Tumors
  - Lymphoma (Anterior)
  - Adenopathy (Middle)
  - Neurogenic (Posterior), Malformations
- Vascular Malformations
- Cysts
Posterior Mediastinum

“Hybrid” malformation
Mediastinum

- Thymus
- Tumors - Lymphoma
- Vascular, lymphatic malformations
- Cysts
Mediastinum
Pediatric Vascular Malformations

• Mediastinal vascular malformations constitute 3-6% of all mediastinal masses
  
  *Fishman et al 1999 Semin Ped Surg 8:92*

• Most common chest wall mass in the child
  • 10% extend into mediastinum

• While a select indication, MRI better than CT at evaluation of extent

Hemangioma
Lymphatic Malformations
Mediastinum

- Thymus
- Tumors - Lymphoma
- Vascular Malformations
- Cysts
Mediastinal cysts

• Advantages of MRI over CT
  • No radiation
  • Better defines cyst relationship to regional structures
  • Better defines cysts complicated by internal proteinaceous debris / milk of calcium

Mediastinal cysts

Hounsfield #'s 60-70
Bronchogenic cysts
The Pediatric Chest

• Mediastinum
• Chest wall
  • Soft tissues
  • Bone
• Pleura
The Pediatric Chest

• Mediastinum
• Chest wall
  • Soft tissues
    • Vascular
    • Fatty
    • Infections / Inflammatory
• Bone
• Pleura
Chest wall – Soft Tissues

- Is mass superficially palpable?
  - Start with ultrasound
  - If unable to characterise, proceed to MRI

Most lesions are benign

- 1-6% of soft tissue masses are malignant
  
  Bissett G (1996) MRI Clinics NA 4:697

Most lesions are “congenital malformations”

- Lymphatic
- Vascular
  
  “Hemangioma”

These combined are the most common soft tissue masses in children


MRI modality of choice for extent of lesion and characterization of flow

Chest wall – Soft Tissues

Lymphatic Malformations

- Most common cervico-thoracic mass of childhood
  - 50% are diagnosed at birth, 90% before school age
  - Chest wall constitutes site of 25% of all lymphatic malformations

- Pathology: dilated lymphatics
  - Can spontaneously hemorrhage, infected

- Can occasionally be massive and life threatening
  - Up to 15% can produce airway compromise
Chest wall – Soft Tissues

• Lymphatic Malformations
  • Ultrasound
    • Simple
      • Cystic with thin internal septations
      • Avascular other than surrounding tissues and septal walls
  • Complex
    • May have internal debris / hemorrhage
    • Septal walls may be thicker
    • May have some venous signals
      • mixed venolymphatic malformations
  • MRI best modality to determining extent
Lymphatic Malformations
Infantile Hemangioma
- Incidence – 18% of all infants
- 3X more common in females
- Most small, superficial, vascular and require no treatment
- Grow rapidly in 1st year of life, gradually involute +/- fatty degeneration
- 50% gone by age 5 years (Garzon et al, 2000, Cutis 66:325)

Ultrasound:
- Solid, echogenic, lobulated
- May or may not be highly vascular
- Mixed arterial and venous signals

MRI if ambiguous or extensive
Chest Wall – Soft Tissues
Hemangioma
Chest Wall – Soft Tissues

Hemangioma
Chest Wall – Soft Tissues - Fat

Lipoma

Lipoblastoma
Tb – recent immigrant palpable chest wall cystic lesion

Chest Wall – Soft Tissues
Infections / Inflammatory
Chest Wall – Soft Tissues
Inflammatory

Diffuse Myositis syndromes

FST2/STIR most sensitive and specific method of identification of myositis and biopsy site localisation

Chest Wall – Soft Tissues
Fibrous – Elastofibroma dorsi

Chest Wall Masses – Soft Tissue

- **Soft Tissue**
  - **Benign**
    - Neurofibroma – usually as part of NF-1
      - MRI can be diagnostic
  - **Aggressive – frequently indistinguishable**
    - Neuroblastoma (as per posterior mediastinal masses)
    - Rhabdomyosarcoma
      - Most common soft tissue malignancy of childhood
        - 10% involve thorax
      - 2\textsuperscript{nd} most common malignancy of chest wall after Ewings

_Shamberger (1989) Cancer 63:774_
Chest Wall Masses – Soft Tissue

Neurofibroma - Teen with NF-1
Thoracic Neuroblastoma
Chest Wall Masses – Soft Tissue

Rhabdomyosarcoma
Chest Wall Masses – Soft Tissue

Recurrent rhabdomyosarcoma

Pre schooler - post radiation 1 yr prior
Recurrence plus pleural effusion, pericardial infiltration
Chest Wall Masses – Bone

• **Benign**
  - Rib anomaly - approx. 2% of general population
  - Chest radiography / ultrasound sufficient for asymptomatic palpable anterior chest wall lesions
  - Osteochondroma
  - Fibrous dysplasia

• **Aggressive** – biopsy diagnosis
  - Ewings sarcoma
  - Neuroblastoma
  - Osteogenic sarcoma; < 5% rib as primary
  - Lymphoma
  - Langerhans Cell Histiocytosis:
    - up to 15% involve thoracic cage

• Metastases from above
• Infection
Child with asymptomatic palpable “bump” at left costochondral junction
Chest Wall – Bone

Pectus and Haller index

“Poland syndrome”
Chest Wall Masses – Bone

Osteochondroma
Chest Wall Masses: Bone

Polyostotic Fibrous Dysplasia

Coronal MIP CT

Coronal IR
Mesenchymal hamartoma
Chest Wall Masses – Bone Infections

Osteomyelitis

Teen with CRMO
Chest Wall Masses – Bone Infections
Ewings Sarcoma Family of Tumors (ESFT)

- Ewings, Askin, PNET = small round blue cell
- Most common chest wall malignancy in kids
  - All share same genetic translocation (chromosome 11;22)
  - 50-60% are classic Ewing’s
  - Peak age 10-15
  - Approx. 15% of ESFT’s are chest wall primary
  - Large exophytic soft tissue mass with rib destruction on all modalities
- Vs. osteomyelitis – both can have fever, high ESR, rib destruction

Crisci (1997) Rad Clin NA p1341
Chest Wall Masses – Bone - malignant

Ewings sarcoma

5 yo

14 yo

15 yo
Chest Wall Masses – Bone - malignant

Ewings sarcoma
Chest Wall Masses – Bone - malignant

Anaplastic Lymphoma
Manubrial osteosarcoma
Chest Wall Masses – Bone - malignant

Years after chest radiation for Wilms

Rib Osteosarcoma
The Pediatric Chest

- Mediastinum
- Chest wall
- Pleura
Pleural MRI in children

- Paucity of pediatric literature
- Mesothelioma rare in kids, unrelated to asbestos
- Sonography is usually first line modality
  - Sonography weakness – poor “total picture”
  - CT weakness – poor soft tissue contrast
- Adults – DWI may differentiate transudative from exudative
  

- Empyema necessitans
  

- Masses including PPB
• Benign
  • Congenital pulmonary malformations (“extralobar”)
  • Lipoma
  • Inflammatory thickening

• Malignant
  • Metastases – most common malignancy
    • Wilm’s, osteosarcoma, neuroblastoma
  • Rhabdomyosarcoma
  • PPB – “minority of cases” of PPB’s thought to originate in the pleura

Extralobar sequestration
Chest Wall / Pleura - Infectious

“Empyema necessitans” Teen with fever, brachial plexopathy

*Streptococcal Pneumonia*
Pleural Masses: Benign

Pleural lipoma
Incidental finding of pleural thickening (“dysplastic”) and abnormal ribs

Fibrous dysplasia

contrast
Pleural Masses: Malignant

Pleural Mets – Osteosarcoma

CT vs MRI
Pleural Masses: Malignant

Pleural Metastases - Testicular Choriocarcinoma
Pleural tumors - primary

Pleuropulmonary blastoma (PPB)

Child with known dicer1 mutation screening “whole body MRI”

Anunpindi SA (2015) AJR 205 (2): 400-408
Pleural tumors - primary

Initial biopsy
Embryonal Rhabdomyosarcoma

Post 2 rounds chemo
PPB at resection
Pleural Rhabdomyosarcoma
Conclusion

• MRI modality of choice
  • Mediastinal cysts
  • Posterior mediastinal masses
  • Most chest wall lesions
  • Complex pleural based lesions

• CT remains gold standard for
  • Children with airway, cardiovascular compromise
  • Small pulmonary parenchymal lesions