MRI OF THE PEDIATRIC CHEST WALL: DEFORMITIES AND MASSES

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Disclosure

• I have no relevant financial disclosure
Overview

- Introduction
- Approach to chest wall imaging
- Examples
- Take home points
Introduction

- Often not first line
- Problem solving
- Characterize lesion
- Extent of lesion
- Uni vs. multifocal?
Introduction

• Chest wall MRI is challenging
  – Breathing
  – Cardiac motion
  – Irregular shape
  – Peripheral location
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• Improving technology
  • Radial blades sequences
  • Respiratory triggering
  • Navigator
  • Cardiac gating
Introduction

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• Improving technology
  • Radial blades sequences
  • Respiratory triggering
  • Navigator
  • Cardiac gating
  • Robust
Introduction

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Cor T1 free breathing
Introduction

- Chest wall MRI is challenging
  - Breathing
  - Cardiac motion
  - Irregular shape
  - Peripheral location
Ax T2 with Fat Sat

Ax T1 Post C with Fat Sat
Improving fat saturation

• Make a more homogeneous magnetic field

  – Place part as close to isocenter as possible
  – Make the volume of the tissue more regular
  – Shim

• Try a different method to null fat
  – Inversion Recovery sequence
  – mDixon

• Use a surface coil
Improving fat saturation

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  – Place part as close to isocenter as possible
  – Make the volume of the tissue more uniform
  – Shim
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  – Breathing
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  – Irregular shape

– Peripheral location
  • Consider surface coil
  • Place area of interest dependent
Protocol

- Ax SS FSE/TSE no FS Rtr or BH
- Cor T1 FSE/TSE no FS FB +/- ECG gating
- Ax T1 Propeller/Multivane
- Ax T2 FSE/TSE FS RTr
- Cor IR RTr
- Ax SSFP no FS RTr or BH
- Ax DWI RTr
- Ax T1 FS pre FB
- Ax T1 FS post FB
- Cor T1 FS post FB

+/- ECG gating
Approach to imaging the chest wall

• Clinical history
Approach to imaging the chest wall

• Clinical history

• Imaging findings
Congenital or developmental abnormalities
  Prominent costal cartilage
  Pectus excavatum
  Pectus carinatum
Neoplasm
  Benign soft tissue tumors
    Infantile hemangioma
    Infantile fibrous hamartoma
    Inflammatory myofibroblastic tumor of the lung (inflammatory pseudotumor)
  Benign osseous tumors
    Osteoid osteoma
    Osteochondroma
    Fibrous dysplasia
    Mesenchymal hamartoma
  Malignant soft-tissue tumors
    Rhabdomyosarcoma
    Malignant peripheral nerve sheath tumors
    Pleuropulmonary blastoma
  Malignant osseous tumors
    Ewing sarcoma family of tumors
    Osteosarcoma
Metastatic disease (most common)
  Neuroblastoma
  Rhabdomyosarcoma
  Lymphoma or leukemia
Infection
  Bacterial infection
  Fungal infection
  Chronic recurrent multifocal osteomyelitis
Trauma
  Accidental trauma
  Nonaccidental trauma (child abuse)
Clinical History – Suspected Mass
Clinical History – Suspected Mass

- Age
- Number/Position
- Duration
- Size
- Pain
- Color
- Texture
Clinical History – Suspected Mass

- Not in isolation
- Combine with each other
- Combine with imaging findings
Clinical History – Suspected Mass

- Age
- Number/ Position
- Duration
- Size
- Pain
- Color
- Texture

- Neonate
- Infant
- Child
- Teenage
Clinical History – Suspected Mass

- Age
- Number/Position
- Duration
- Size
- Pain
- Color
- Texture
Clinical History – Suspected Mass

Age  Number/Position  Duration  Size  Pain  Color  Texture

Neonate
Clinical History – Suspected Mass

Age
Number/Position
Duration
Size
Pain
Color
Texture

Infantile Myofibroma

Neonate
Myofibroma/myofibromatosis

- Solitary vs multicentric
  - Solitary: boys, head, neck, trunk
  - Multicentric: soft tissues, bones, viscera

- Most common fibrous tumors of infancy; 90%< 2 years, 60% at birth

- Natural history is spontaneous regression
Myofibroma/myofibromatosis - MRI

- T1WI: Low signal
- T2WI: Variable signal
- “Target sign” with contrast – peripheral/rim enhancement with central necrosis
Clinical History – Suspected Mass

- Age
- Number/Position (Single, Multiple)
- Duration
- Size
- Pain
- Color
- Texture
- Anterior
- Other
Clinical History – Suspected Mass

- Age
- Number/Position: Single (Anterior, Other)
- Duration
- Size
- Pain
- Color
- Texture
“Painless anterior chest wall mass”

Asymptomatic, Palpable, Anterior Chest Wall Lesions in Children: Is Cross-sectional Imaging Necessary?¹

Radiology 1997; 202:829-831

- n = 27
- Asymptomatic palpable anterior chest wall lesions
- All lesions benign with no therapy necessary
- 21 lesions related to “variant” osseous anatomy
Clinical History – Suspected Mass

- Number/Position: Single
  - Anterior
  - Other
Clinical History – Suspected Mass

- Age
- Number/Position
  - Single
    - Anterior
    - Other
- Duration
- Size
- Pain
- Color
- Texture
Prominent costochondral junction

- Adolescent
  - More body awareness
  - Body shape changing

- Painless, non-tender, anterior chest wall, hard

- +/- Bifid rib
Variant anatomy - Deformities
Variant anatomy - Deformities

- Soft tissue
- Osseous
Variant soft tissue anatomy

- Poland syndrome
- Accessory breast tissue
Accessory Breast Tissue

- Most commonly in axilla
- Can become more apparent with puberty, pregnancy, and lactation
Variant osseous anatomy

- Prominent costochondral junction
- Bifid rib
- Pectus deformity
- Tilted sternum
Pectus deformities

- Pectus carinatum
- Pectus excavatum
Pectus Excavatum (PE)

- Traditionally evaluated with CT and echocardiography

- Now combine wall measurements with functional cardiac MR

- Haller index \( \geq 3.25 \) – candidate for repair
Problems with Haller index
Problems with Haller index

• Overlap between pectus patients and normal controls

• Relies on shape of the chest
Overlap with controls

Correction index A novel measure for pectus excavatum…https://doi.org/10.1016/j.jpedsurg.2011.09.009
Shape of the chest

The Depression Index: an objective measure of the severity of pectus excavatum…http://dx.doi.org/10.1016/j.jpedsurg.2014.11.043
Shape of the chest

Circular Chest 2.96
Index Pectus Index
Elliptical Chest 5.77

The Depression Index: an objective measure of the severity of pectus excavatum…http://dx.doi.org/10.1016/j.jpedsurg.2014.11.043
Shape of the chest

Circular Chest
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5.77

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Additional metrics for PE

- Correction Index
- Depression Index
Correction and Depression index

Correction index = \frac{(A-B)}{A} \times 100

Depression index = \frac{A}{B}

- Less reliant on chest shape for measurements
- No overlap between normal and PE patients when threshold of 10% (CI) and 0.2 (DI) are chosen
<table>
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<tr>
<th></th>
<th>Circular Chest</th>
<th>Index</th>
<th>Elliptical Chest</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Pectus Index</td>
<td></td>
</tr>
<tr>
<td>Depression Index</td>
<td>2.96</td>
<td></td>
<td>5.77</td>
</tr>
<tr>
<td>Correction Index</td>
<td>26.7%</td>
<td></td>
<td>47.9%</td>
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<td>0.86</td>
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<td>0.91</td>
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The Depression Index: an objective measure of the severity of pectus excavatum…http://dx.doi.org/10.1016/j.jpedsurg.2014.11.043
Clinical History – Suspected Mass

- **Age**
- **Number/Position**
  - Single
  - Multiple
- **Duration**
- **Size**
- **Pain**
- **Color**
- **Texture**

- **Anterior**
- **Other**
Neurofibromatosis type 1
Osseous
Fibrous dysplasia
Fibrous dysplasia

• Usually asymptomatic

• Can expand and deform bone

• Monostotic versus polyostotic

• Lateral or posterior ribs
Fibrous dysplasia - MRI

- T1WI: isointense to muscle

- T2WI: heterogeneously hyperintense, depends on extent of woven bone within the lesion

- Enhancement: intense in active lesions, mild in inactive lesions

- Expands and is confined to bone
Clinical History – Suspected Mass

Age  Number/Position  Duration  Size  Pain  Color  Texture

New  Old
Clinical History – Suspected Mass

- Age
- Number/Position
- Duration
- Size
- Pain
- Color
- Texture

- Size:
  - Stable
  - Changing
    - Decreasing
    - Enlarging
  - Variable
Clinical History – Suspected Mass

- Age
- Number/Position
- Duration
- Size
- Pain
- Color
- Texture

Size:
- Stable
- Changing
  - Enlarging
  - Decreasing
  - Variable
2 month old with a rapidly enlarging mass
2 month old with a rapidly enlarging mass
Fibrosarcoma

- Infantile versus adult types

- Infantile aka congenital fibrosarcoma:
  - < 5 years; 30% present at birth
  - Rapidly growing; extremities >70%

- Adult:
  - 10-15 yrs
  - Slower growing; proximal extremities & trunk
Fibrosarcoma - MRI

- Infantile type: Well demarcated
- T1WI: isointense to muscle
- T2WI: Heterogeneously hyperintense
- Heterogeneous enhancement
Infantile type
Infantile type
Clinical History – Suspected Mass

- Age
- Number/Position
- Duration
- Stability
- Pain
- Color
- Texture

Stability:
- Stable
- Unstable

Unstable:
- Enlarging
- Decreasing
- Variable
Lymphatic malformation

- Macro vs microcystic
- Septal enhancement of cysts
- **Variable** imaging appearance and size due to hemorrhage or proteinaceous fluid
- Most typically involve soft tissues
- May not respect tissue planes
- May be multicentric
- No flow in lesions
Clinical History – Suspected Mass

- Age
- Number/Position
- Duration
- Stability
- Pain
- Color
- Texture

Painful
Painless
Clinical History – Suspected Mass

- Age
- Number/Position
- Duration
- Stability
- Pain
- Color
- Texture

Color: Red/Blue
Pain: None
Venous malformation

- Cluster of slow flow venous channels
- Most often subQ +/- intramuscular
- Often crosses tissue planes
- Bone involvement uncommon
Venous malformation - MRI

- Well circumscribed lobulated mass
- Phleboliths, calcified in 30%
Venous malformation - MRI

- **T1WI**: Isointense to muscle
  - Uncalcified phleboliths may be bright
  - **Bright fat** often interspersed between channels
- **T2WI**:
  - Very bright serpentine vessels
  - Thin septae
- **Diffuse or patchy enhancement**
- **Dynamic post contrast**: gradual filling
Clinical History – Suspected Mass

- Age
- Number/Position
- Duration
- Stability
- Pain
- Color
- Texture

- Hard
- Firm
- Soft
Conclusion

• Newer sequences improving robustness of chest MR

• Excellent tissue characterization and contrast resolution

• Good for assessing the extent of lesions
Conclusion

• Need to consider clinical history

• Combine clinical with MR appearances

• Asymptomatic anterior chest wall lesions are not worrisome
THANK YOU