URLs

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- Slides at:
  http://www.cincinnatichildrens.org/research/div/radiology/present.htm
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Pediatric HRCT

- What do I do with a request for an HRCT in a child?
- How can I get better images?
- What do I say about the images once I’ve got them?
High-Resolution CT

- HRCT provides a low dose sampling technique for diffuse or widespread abnormalities.
- HRCT does not evaluate the mediastinum or central airways.
- HRCT is very unlikely to be useful if conventional CT is normal.
High-Resolution CT

- High-resolution CT is a misleading term
- "Limited sample parenchymal evaluation CT" is more accurate
- HRCT is more technically demanding than conventional CT
- HRCT is only useful if high quality images are obtained
HRCT Technique
HRCT Technique

- Weight/size/age based mAs
- kVp 80-120
  - Increased kVp markedly increases dose
- 1mm sections
- 7mm (infants) to 20mm (limited survey) intervals for inspiratory images
- Maximum 1:2 inspiratory to expiratory ratio, minimum of 4
- Fastest scan speed
Dose Considerations

- Perform HRCT first if unsure whether to do conventional or HRCT
- Scan limited area when appropriate
- Evaluate the relative dose of available CT scanners
- Use breast shields

Fricke BL, et al. AJR 2003;180:407-11
Breast Shields

30% lower breast dose, no increase in noise
Patient Preparation for HRCT

- HRCT requires cooperation or control
- Inspiratory images 4 to 6 years old
- Expiratory images 6 to 8 years old
- Coach in room helpful until 10-12 years old
Patient Preparation

- Explain and practice the procedure before entering the scan room
- Practice again on the scanner table
- Talk your patient through the entire procedure
- It helps if an adult stays in the room during scanning
New Imaging Techniques

- Imaging quietly breathing young children is not adequate for HRCT
  - Motion degrades images
  - Lung volumes are variable, and level of inspiration is unknown
  - Comparable inspiratory and expiratory images cannot be obtained
Controlling Lung Volume

- Decubitus imaging
- Controlled ventilation CT
- General anesthesia
Decubitus Imaging
Decubitus Imaging

- Perform initial HRCT
- Place child in lateral decubitus position
- Down side is expiratory, up side is well inflated

2 Year Old

Normal appearance

Courtesy Javier Lucaya, MD
Multiple Bronchial Atresias

Courtesy Javier Lucaya, MD
CASE 4

5 Year Old, ? Bronchiectasis

Courtesy Javier Lucaya, MD
5 year old

Bronchi abut the mediastinal pleura indicating bronchiectasis

Courtesy Javier Lucaya, MD
Controlled Ventilation CT
Controlled Ventilation CT (CVCT)

- Mask ventilate sedated child
- $\text{CO}_2$ and chest stretch receptors produce 10-15 seconds of apnea
- Obtain inspiratory and expiratory images during apneic period

Long et al. Radiology, Aug 1999; 588-93
2 Year Old with CF

Courtesy Frederick R. Long, MD
2 yo with CF, Inspiratory CVCT

Courtesy Frederick R. Long, MD
2 yo with CF, CVCT

Courtesy Frederick R. Long, MD
Controlled-Ventilation CT

- Safe; technique used for infant PFTs on thousands of children
- Effective; success rate > 90%
- Requires a trained RT or other HCP
- Must have a well-established sedation program in place
General Anesthesia
General Anesthesia
Inspiratory and Expiratory Images
General Anesthesia

- The greatest technical problem is atelectasis
- Begin scanning as soon as possible
- Maintain 30 cm water inspiratory pressure with frequent sighs
- Insist on prone images if posterior opacities are present
Interpreting Pediatric HRCT

“Evaluation of the lung parenchyma is not straightforward in neonates and infants”

David Hansell, HRCT of Diffuse Lung Disease, Radiol Clin North Am, Nov 2001
Interpreting Pediatric HRCT

- Evaluate the large and small airways
- Identify the predominant parenchymal abnormalities
  - Ground glass  Nodules  Cysts
  - Emphysema  Linear / reticular densities
- Adult terms work well for description
- Diagnostic possibilities are often very different
Illustrative Cases

- Children are not little adults
- Common things occur commonly
- Make friends with your pathologist
- A pediatric pulmonologist may be more helpful than a radiologist
15 Year Old, Shortness of Breath
Idiopathic Pulmonary Fibrosis

- Appearance in children often associated with autoimmune/connective tissue disorders
- Little fibrosis on biopsy
- May respond to steroids or hydroxychloroquine
- Often stable for long periods of time

Increasingly restrictive criteria in adults

“Adult” IPF rarely seen in children

Should not be diagnosed by imaging appearance without biopsy
11 yo with Frequent Infections
Tree-In-Bud

- Inspissated material in distal bronchioles
- Frequently ascribed to infection, especially non-tuberculous mycobacterium
- In children without an underlying condition probably most often seen with chronic aspiration
Three Children with Tachypnea
2 year old, Follicular Bronchiolitis
8 year old, Follicular Bronchiolitis
4 year old, Nonspecific Cellular Infiltrate
Follicular Bronchiolitis

- Commonly associated with HIV, collagen vascular disease, and congenital immune deficiency
- Good prognosis in adults, can be progressive in children
Lymphoid Infiltrative Disorders of the Lung

- Lymphocytic bronchiolitis
- Lymphoid interstitial pneumonitis
- Follicular Bronchiolitis
- Lymphocytic alveolitis

Pathologic diagnosis depends on the predominant cell type, the location, and the degree of follicle formation.
Pathology Slide Review

- The 2 yo with follicular bronchiolitis and the 4 year old with a nonspecific cellular infiltrate had a nearly identical pathologic appearance.
- Diagnosis was most likely lymphoid bronchiolitis in both cases.
- The 8 year old with follicular bronchiolitis had a very different appearance.
Neonate with Cyanosis

Courtesy Robin Deterding, MD
Congenital Pulmonary Alveolar Proteinosis
Pulmonary Alveolar Proteinosis

- Proteinaceous fluid fills alveoli
- Variable prognosis, usually poor in newborns
- PAP is a specific pulmonary response to insult, but it is not an etiology
- Associations include surfactant protein abnormalities, inhalation exposure, lipoid aspiration, immune compromise
Pulmonary Alveolar Proteinosis

- Prognosis in children depends on etiology
- Identification of PAP requires a complete evaluation for known associations
Five yo with Chronic Lung Disease
13 yo with Chronic Lung Disease
Surfactant Protein C Deficiency

- One of several surfactant protein abnormalities
- Increasingly recognized as a cause of chronic lung disease
- Variable course and presentation
- Infection likely causes lung damage out of proportion to the infection
Sisters with Surfactant Protein C Deficiency

5 year old

13 year old
Niemann-Pick Type B

- Enzyme defect leads to buildup of sphingomyelin
- Type B does not involve the CNS, symptoms are abdominal distension and respiratory
- Abnormal macrophages ("foam cells") accumulate in the lungs producing nodular and ground glass opacities
Niemann-Pick Type B

- Pathophysiology of lung disease and imaging appearance is well understood
- There is no significant relationship between the severity of radiographic abnormality and the severity of respiratory symptoms
Conclusion

- New techniques allow high quality images in patients of all ages
- Identifying the presence and location of disease is an important contribution
- HRCT findings are rarely specific, and lung biopsy will often be needed
Thank You for Your Attention

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