Complications of Pediatric Sinusitis

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Outline

1. Paranasal sinus anatomy
2. Definitions
3. Indications for imaging
4. Imaging modalities
5. Patient presentation
6. Summary
Sinus Anatomy

[Diagram of sinus anatomy]

- Frontal sinus
- Sphenoidal sinus
- Maxillary sinus
- Ethmoidal sinus
- Superior concha
- Rod passed from sphenoidal sinus to sphenoethmoidal recess
- Sphenoidal sinus
- Opening of middle ethmoidal sinus
- Opening of pharyngotympanic tube
- Opening of maxillary sinus (maxillary ostium)
- Inferior concha (cut)

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Essential Clinical Anatomy, 2002
Sinus Plain Films

Occipitofrontal View

Lateral View

F=Frontal Sinus
O=Orbit
M=Maxillary Sinus
E=Ethmoid Sinus
MT=Maxillary Teeth
N=Nasal Cavity
ZA=Zygomatic Arch
MndA=Angle of Mandible
OdP=Odontoid Process (Dens)

F=Frontal Sinus
E=Ethmoid Sinus
Sp=Sphenoid Sinus
M=Maxillary Sinus

ST=Sella Turcica (Pituitary Fossa)
ClnP=Posterior Clinoid
NPh=Nasopharynx
SPal=Soft Palate

http://xray.20m.com/photo.html
## Sinus Development

<table>
<thead>
<tr>
<th>Sinus</th>
<th>Appearance</th>
<th>Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary</td>
<td>Embryo</td>
<td>12-20</td>
</tr>
<tr>
<td>Ethmoid</td>
<td>Birth</td>
<td>12</td>
</tr>
<tr>
<td>Sphenoid</td>
<td>1-3</td>
<td>7-14</td>
</tr>
<tr>
<td>Frontal</td>
<td>1-4</td>
<td>≥ 12</td>
</tr>
</tbody>
</table>

Kronemer and McAlister, 1997
Acute vs Chronic Sinusitis

Acute
- Bacterial infection of the paranasal sinuses
- Symptoms last less than 30 days
- Complete resolution

Chronic
- Inflammation of the paranasal sinuses
- Symptoms last more than 90 days
- Persistent residual respiratory symptoms of cough, rhinorrhea and nasal obstruction

American Academy of Pediatrics, 2001
# Complications of Sinusitis

## Orbital
1. Edema
2. Preseptal cellulitis
3. Postseptal cellulitis
4. Subperiosteal abscess
5. Orbital abscess
6. Cavernous sinus thrombosis

## Intracranial
1. Epidural empyema
2. Subdural empyema
3. Meningitis
4. Cerebritis
5. Parenchymal abscess
6. Mycotic aneurysm
7. Brain infarction

## Subgaleal
1. Pott’s puffy tumor
2. Osteomyelitis
Indications for Imaging

1. Purulent nasal discharge >10 days
2. Recurrent or persistent clinical sinusitis
3. Preoperative evaluation for functional endoscopic sinus surgery (FESS)
4. Suspected complication
5. Complex sinus disease
6. Suspected fungal sinusitis

*Imaging is not recommended for uncomplicated acute sinusitis
Imaging Modalities to Diagnose Chronic Sinusitis

Plain Film Radiograph
- Low sensitivity and therefore seldom used
- Caldwell (anteroposterior) - frontal, ant ethmoid
- Normal lateral - sphenoid
- Waters (occipitomental) - maxillary, ethmoid

CT
- High sensitivity and therefore the test of choice
- Coronal projection most accurate view of sinus anatomy
- Bone window on bone algorithm for sinus views
- Contrast for intracranial pathology
- Imaging for functional endoscopic sinus surgery (FESS)
- Radiation exposure
# Imaging Modality for Complications of Sinusitis

**MRI**
- Intracranial pathology and complex sinus disease
- Lacks bony detail of sinus anatomy
- Long image collection time may require sedation
- No radiation

<table>
<thead>
<tr>
<th>Modality</th>
<th>Anatomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Anatomy</td>
</tr>
<tr>
<td>T1 + Gadolinium</td>
<td>Vasculature, malignancy</td>
</tr>
<tr>
<td>T2</td>
<td>Inflammation/fluuid</td>
</tr>
<tr>
<td>FLAIR</td>
<td>Inflammation</td>
</tr>
<tr>
<td>Diffusion weighted</td>
<td>Ischemia</td>
</tr>
<tr>
<td>Angiography</td>
<td>Vasculature</td>
</tr>
</tbody>
</table>

American College of Radiology, 2006 and Boyle, 2006
Abnormal Sinuses in Children

Incidence of abnormal sinus CT in children with no history of sinusitis

- 55% had abnormal sinuses
- 33% had air fluid levels in sinuses

High incidence (62%) of viral URI symptoms or allergic rhinitis within the past 2 weeks

Maning et al, 1996
Correlation of clinical symptoms of chronic sinusitis with CT radiographs

- **Paranasal sinuses opacification**
  0 none, 1 partial, 2 complete
  Assign score independently to left and right paranasal sinuses

- **Osteomeatal complex**
  0 not occluded, 2 occluded

- **Sinus not developed**: 0

Score: 0-2 no disease, 3-4 equivocal, \(\geq 5\) chronic sinusitis

*Bhattacharyya et al, 2004*
Patient Presentation
Patient BE

- 11 year old previously healthy girl
- 4 day history of headache, lethargy, fever, malaise and sinus congestion
- Seizure during transfer from OSH
- No significant past medical history
Patient BE: Sinusitis on CT

Coronal CT Bone Window
1. Opacification of the ethmoid sinuses
2. Opacification of the right maxillary sinus
3. Concha bullosa a normal variant

Axial CT Bone Window
4. Near total opacification of the frontal sinuses
Differential of Opacified Sinsuses

1. Sinusitis
   - GERD
   - Immune deficiency syndrome
   - URI
2. Trauma
   - Hemorrhage
   - Edema
3. Allergy
4. Cystic fibrosis
5. Inflammatory mass
   - Mucocele
   - Cyst
   - Pyocele
   - Polyp
6. Malignancy
   - Burkitt Lymphoma
   - Osteoma
7. Granulomatous Disease
   - Sarcoidosis
   - Tuberculosis
8. Dysfunctional cilia
   - Kartagener’s syndrome
   - Immotile cilia syndrome

Reeder, 2003
Patient BE: Sinusitis on CT and MRI

Axial CT Bone Window
1. Opacification of the ethmoid sinuses
2. Opacification of the sphenoid sinuses
3. Fluid in the right mastoid air cells

Axial MR T2
4. Chronic sinusitis in the maxillary sinuses
5. Frothy appearance of acute sinusitis in the maxillary sinus

Courtesy of Dr Hines-Peralta
1. Low signal areas in the anterior and left lateral temporal lobes indicating regions of restricted diffusion suggestive of edema or fluid

2. Low signal areas in the anterior and left lateral temporal lobe surrounded by a rim of enhancement consistent with empyema
Patient BE: Subdural Empyema on MRI

Coronal MR T1 with Contrast
1. Low signal areas surrounded by a rim of enhancement consistent with empyema on coronal section

Sagittal MR T1 with Contrast
2. Low signal areas surrounded by a rim of enhancement consistent with empyema on sagittal section

Courtesy of Dr Hines-Peralta
Patient BE: Meningitis on MRI

Axial MR T1 with Contrast

1. Focal areas of subtle enhancement of the meninges consistent with meningitis
Companion Patient 1: Meningitis on MRI

1. Meninges appear as a ring of low signal intensity

2. Ring of enhancement surrounding the cerebellum consistent with meningitis

http://www.math.uno.edu/~jensen/L/neuropath/images.htm
Patient BE: Cerebral Edema on MRI

Axial MR T1 Pre-contrast

1. Midline shift
2. Compression of the anterior horn of the lateral ventricle
3. Compression of the left posterior horn of the lateral ventricle
4. Diffuse effacement of the cortical gyri shown best in the left parietal lobe

Courtesy of Dr Hines-Peralta
Patient BE: Cerebral Edema on MRI

Axial MR T1 Post-contrast

1. Low signal areas indicating restricted diffusion in the frontal lobes bilaterally and the temporal lobe suggestive of edema or a fluid collection

Axial MR T2-weighted

2. High signal areas that follow the pattern of the gyri in the frontal lobes bilaterally and the temporal lobe more suggestive of edema than a fluid collection
Patient BE: Cerebral Ischemia on Diffusion-Weighted Imaging

Axial MR Diffusion-Weighted Image

1. High signal areas that follow the pattern of the gyri in the frontal lobes bilaterally and the temporal lobe localizing areas of cerebral ischemia
Axial CT Brain Window
1. Intraventricular shunt
2. Craniectomy site and herniation of the left cerebral hemisphere beyond the skull margin
3. Post surgical aberrant air collections

Patient BE: Shunt & Craniectomy on CT

Courtesy of Dr Hines-Peralta
Patient BE: Follow-up Axial CT Brain Window
1. Site of second craniectomy
2. Suspected abscess in left parietal lobe. Finding needs to be confirmed on MRI

Companion Patient 2: Axial MR T1 with Contrast
3. Pair of rim enhancing lesions with low signal intensity indicating the presence of an intraparenchymal abscess
Summary of Patient BE

- 11 year old girl with symptoms of sinusitis suspected of having complications
- Coronal CT showed opacification of the paranasal sinuses
- MRI showed subdural empyema, meningitis, cerebral edema and cerebral ischemia
- An interventricular shunt was placed and a craniectomy was performed
- CT showed a second craniectomy site and the development of a possible parenchymal abscess and
Companion patients are shown to illustrate the following radiographic findings:

- Orbital cellulitis and subperiosteal abscess
  - the most common complication of sinusitis
- Cavernous sinus thrombosis - a must not miss diagnosis
- Pott’s Puffy Tumor
Companion Patient 3: Coronal CT with Contrast Soft Tissue Window
1. Opacification of the ethmoid sinuses
2. Air-fluid level in the right maxillary sinus
3. Periobital soft tissue edema
4. Hypoplasia of the left maxillary sinus

Companion Patient 4: Axial CT with Contrast Soft Tissue Window
5. Proptosis of the right orbit

Kirsch and Turbin, 2005 and Reid, 2004
Cavernous Sinus Thrombosis on MRI

Companion Patient 5: MR Angiogram
1. Cavernous sinus thrombosis

Companion Patient 5: Coronal MR T1 Post-contrast
2. Wall thickening of the right cavernous sinus

Zimmer et al, 2006
Companion Patient 6: MR T1 with Contrast

1. Sagittal view of opacified frontal sinus with fistula to soft tissue overlying the frontal bone and soft tissue edema
2. Axial view showing the same
Sinusitis, complications and correlation with imaging

Coronal CT  MR T1 ± contrast  MR T2 & T2 weighted
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