Head Trauma
Imaging of Intracranial Bleeds

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Our Patient

- 85 y/o woman fell at home, hitting R temple on corner of table
- ambulated then became unresponsive
- In the ED . . .
  - Patient lethargic
  - No external signs of injury
  - pupil size R 3.5 L 2.5 responsive to light
  - BP 208/palpable HR 112
Menu of tests for imaging head trauma

1. Head CT
2. Head MRI

Noncontrast Head CT is the test of choice as:

- The patient is accessible if emergency resuscitation is needed
- IV contrast is not needed
- Fast
- Great for identifying fractures and bone fragments
- Great for identifying acute bleeds; they appear hyperdense
- Great for evaluating edema and shift/herniation
In order to recognize the abnormal, you first need to know the appearance of the normal.

<table>
<thead>
<tr>
<th>CT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone</td>
<td>White</td>
</tr>
<tr>
<td>Calcium</td>
<td>White; Acute hemorrhage is usually white</td>
</tr>
<tr>
<td>Brain parenchyma</td>
<td>Light grey; White matter is darker than grey matter</td>
</tr>
<tr>
<td>CSF</td>
<td>Very dark grey; Sulci, cisterns and ventricles</td>
</tr>
<tr>
<td>Air</td>
<td>Black; Nasal cavity, sinuses, mastoid air cells</td>
</tr>
</tbody>
</table>
Normal Anatomy

- Ca caudate
- WM white matter
- GM grey matter
- SP septum pellucidum
- CP choroid plexus
- LV lateral ventricles
- Me medulla
- FV fourth ventricle
- CB cerebellum
- FC falx cerebri
Normal Anatomy

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- GM grey matter
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- Ci Cisterns
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Normal Anatomy

- Sutures
- Sinuses
  - FS Frontal
  - EA Ethmoid Air Cells
  - SS Sphenoid
  - MS Maxillary
  - MA Mastoid Air Cells
- NA Nasal Airway
- EC Ear Canal
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Systematic Approach to reading a Head CT

I. Quality Control

– Check patient name, study date, time
– Check standard views are included
  • properly positioned contiguous images from foramen to cranial vertex
  • correct scanner settings; Brain W/L: 80/40
    Bone W/L: 2000/350
– Determine if IV contrast was given
II. Check Brain Parenchyma
• Check grey/white differentiation
• Gyri
• Look for blood
• Surgeons need to know . . . (size of hematoma, extent of midline shift, herniation)

III. Check CSF spaces: Ventricles, Cisterns and Sulci
• CSF spaces (ventricles and cisterns)
  – size, symmetry, midline shift
  – herniation
    • Subfalcine – cingulate gyrus crosses falx
    • Transtentorial – temporal lobe into tentorial notch
    • Cerebellar – cerebellum into foramen magnum
Systematic Approach to reading a Head CT (cont’d 2)

IV. Check face and skull bones on bone windows
   – Do not confuse sutures with fracture especially in pediatric patients

V. Check “air spaces”
   – Sinuses
   – Nasal airway
   – Ear Canals and Mastoid air cells
A Head CT with out IV contrast was obtained on our patient. Let’s review it first fast and then systematically.
Emergency Head CT w/o contrast 2h s/p fall.
W/L: 80/40
Emergency Head CT w/o contrast 2h s/p fall.
W/L: 2000/350
Our Patient’s Head CT

Film findings:

• R frontoparietal subdural hematoma (6 mm)
• Midline marker
• R temperoparietal epidural hematoma (1.8 cm)
• 6 mm leftward shift of lateral ventricles
• Right lateral ventricle
• Left lateral ventricle
• Effacement of R sulci
Locations for intracranial blood include:
1. Epidural hemorrhage
2. Subdural hemorrhage
3. Subarachnoid hemorrhage
4. Intraparenchymal hemorrhage

Differentiation between epidural and subdural may be difficult
Anatomy of intracranial bleeds

Epidural

Subdural

Woo and Nesathurai, 2000
Epidural

- “classic” brief LOC, lucid interval, deteriorating mental status
- most commonly middle meningeal artery, vein, venous sinus
- biconvex and confined by intracranial sutures
- craniotomy to evacuate hemorrhage and for hemostasis

http://www.rad.uab.edu
Subdural Hematoma

- altered consciousness, pupil abnormalities
- shearing of bridging veins
- concave, not confined by sutures
- mass effect can cause herniation or reduced perfusion
- blood toxic effect on tissue
- monitor ICP, high mortality rate
- acute, subacute, chronic or combination depending on time of presentation

http://www.med.wayne.edu/diagRadiology/TF/Neuro/
Subarachnoid Hemorrhage

- shearing of microvessels in subarachnoid space
- often benign in trauma
- most commonly associated with ruptured aneurysm “worst headache of my life”
- hyperdensities indicate blood in
  - suprasellar cistern
  - sylvian cistern
  - perimesencephalic cistern
  - ambient cistern
  - quadrageminal plate cistern

Araiza & Araiza, 1997
Parenchymal Hemorrhage

• presents with behavioral and cognitive changes
• round or irregular high density lesions
• damage to small arterioles in brain parenchyma
• result from lacerations or coalescence of contusions
• often associated with coup countrecoup injuries
• most common in frontal and temporal lobes

http://www.xray2000.f9.co.uk/Ibase2/Brain/
Potential Shortcomings of CT in the Imaging of Head Trauma

- Location of pathology
  - Temporal
  - Posterior Fossa
- Isointense bleeds
  - anemia
  - coagulopathies
  - dilution of blood with CSF

http://www.med.wayne.edu/diagRadiology/TF/Neuro/
Management Priorities

Maintain perfusion and oxygenation of brain
ICP at or below 15 mm Hg

Medical Therapy
– diuretics
– blood pressure control
– elevation of head
– seizure prophylaxis
– sedation
– mild hypothermia

Surgical
– Ventriculostomy
– Evacuation
– Craniotomy
Patient’s course

• AD taken emergently to OR for evacuation of R frontal temporal hematomas
• Significant improvement in neurological function post operatively
• Patient discharged to home on POD# 5 in stable condition
Our Patient’s Follow-up scans

On presentation

s/p evacuation

BIDMC

POD #1

BIDMC
Follow-up scans

s/p evacuation

POD # 1

Surgical Subdural air

Craniotomy defects

BIDMC

BIDMC
## Summary

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Clinical Signs</th>
<th>CT signs</th>
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<tbody>
<tr>
<td>EPIDURAL</td>
<td>Lucid interval followed by deteriorating mental status</td>
<td>biconvex (lentiform) confined by sutures</td>
</tr>
<tr>
<td></td>
<td>Altered consciousness, pupil abnormalities, can be gradual in onset</td>
<td>Bi concave, not confined by sutures</td>
</tr>
<tr>
<td>SUBDURAL</td>
<td>“Worst headache of life” more often associated with aneurysm, HTN</td>
<td>Hyperdensities in cisterns (star pattern)</td>
</tr>
<tr>
<td>SUBARACHNOID</td>
<td>Behavioral and cognitive changes, coup countrecoup injuries</td>
<td>round or irregular hyperdense lesions</td>
</tr>
<tr>
<td>PARENCHYMAL</td>
<td></td>
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Head Injury Facts

- 8 million people in the U.S. suffer head injury each year
- 500,000 hospitalized
- Leading causes MVA (50%) Falls (21%)
- Leading cause elderly falls (75%)

- Please buckle up and wear helmets on bikes, scooters, and rollerblades.
References

• Kushner D. “Mild Traumatic Brain Injury: Understanding Manifestations and Treatment” * Archives of Internal Medicine* 158 (15) 1617-24
• http://www.radiology.wisc.edu/Med_Students/neuroradiology/NeuroRad/NeuroRad.htm
• http://brighamrad.harvard.edu/education.html
• Johnson KA & Becker JA, http://www.med.harvard.edu/AANLIB/home.html
• http://www.neuropat.dote.hu/nrad2.htm
• http://www.med.wayne.edu/diagRadiology/TF/Neuro/NeuroTF.html
• http://www.rad.uab.edu
• http://www.xray2000.f9.co.uk/Ibase2/Brain/
Acknowledgements

• Vasant Narasimhan
• Daniel Saurborn M.D.
• Wayne Monsky M.D.
• Beverlee Turner for her support and PowerPoint expertise.

The end.