

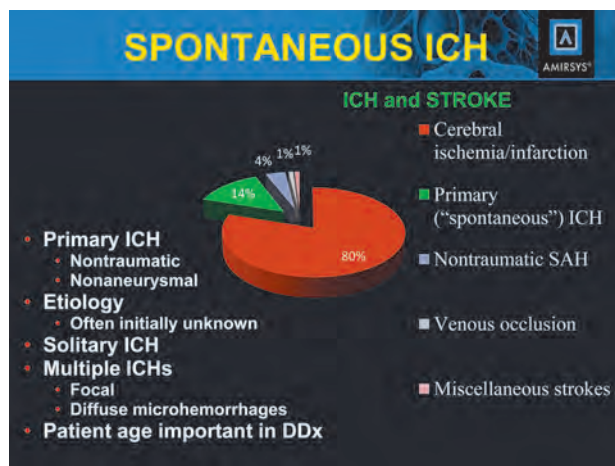
НЕТРАВМАТИЧЕСКИЕ ВНУТРИЧЕРЕПНЫЕ КРОВОИЗЛИЯНИЯ

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UNDERSTANDING NONTRAUMATIC INTRACRANIAL HEMORRHAGE

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"UNEXPLAINED" ICH

Imaging Evaluation

- NECT**
 - Initial screening
 - +/- CECT
 - +/- CTA
- MR**
 - Staging/further evaluation
 - T1, T2, FLAIR, T2* (GRE, SWI), DWI
 - +/- MRA/MRV
- DSA**
 - If no clear cause

IMAGING FINDINGS IN ICH

- Vary, depending on
 - Modality
 - Clot morphology
 - Clot age
- NECT**
 - Only determinant = electron density (HU)
 - Protein concentration
 - Globin moiety
 - Not iron in Hgb!
- MR**
 - Multiple factors determine signal intensity (SI)
 - Pulse sequence
 - Oxygenation status of hemoglobin

NECT OF ACUTE ICH

Clot is Generally Hyperdense

- Hyperacute (minutes)**
 - Clot heterogeneous (40-60 HU)
- Acute (1-2h to 2-3 days)**
 - Clot solidifies, retracts
 - Density ↑ to 60-80 HU
 - Becomes more homogeneous

NECT OF ACUTE ICH

When is Clot NOT Hyperdense?

- Isodense acute clot**
 - Extreme anemia (Hgb < 8-10)
- Inhomogeneous acute clot**
 - Coagulopathy
 - Iatrogenic (anticoagulation)
 - Intrinsic clotting defect
 - Rapid bleeding
- NECT**
 - Fluid-fluid levels
 - "Swirl sign"

"WEIRD" HEMORRHAGE?

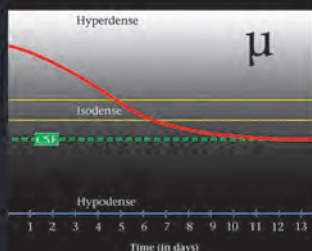
Think Coagulopathy!!

Hemolysis, elevated liver enzymes, low platelets (HELLP)

NECT OF EVOLVING ICH

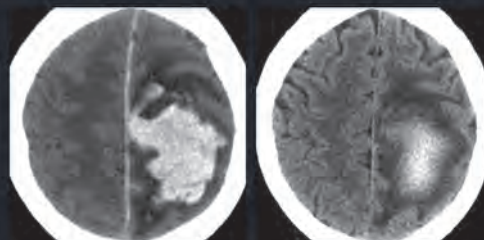
Time vs. Density (Relative to Gray Matter)

- Subacute ICH (3-10d)
 - Progressive ↓ density
 - Decreases 1.5H/day
- Becomes isodense
 - 7-10 days



NECT OF SUBACUTE ICH

Density Gradually Decreases (Outside/In)

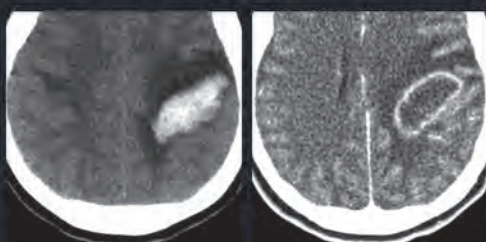


Initial

10 days later

CECT OF SUBACUTE ICH

Ring Enhancement

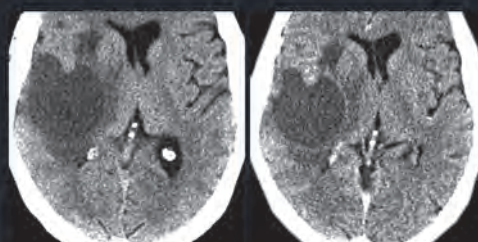


Acute

10 days later

NECT OF CHRONIC ICH

Generally Hypodense After 10days-2 Weeks

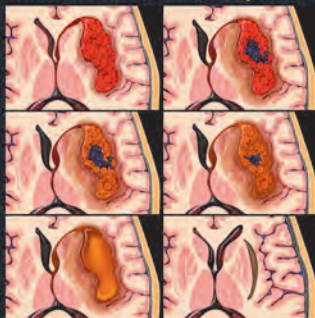


NECT

CECT

MR OF ICH

Clot Age, Oxygenation Status of Hgb, Intra- vs. Extracellular, Pulse Sequence



"Outside-Inside" Evolution

HEMOGLOBIN vs. S.I.

HEMOGLOBIN

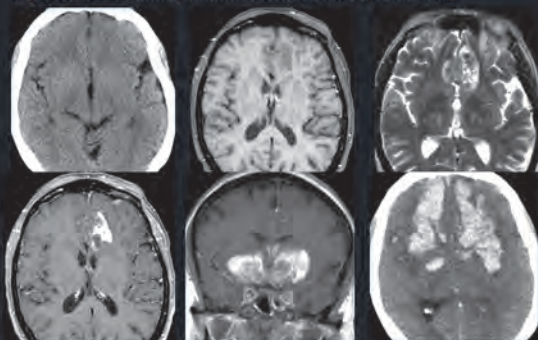
- Hyperacute (minutes to few hours)
 - Oxyhemoglobin
- Acute (6h-3days)
 - Deoxyhemoglobin
- Early subacute (3-7 days)
 - DeoxyHgb center
 - Intracellular methHgb rim
- Late subacute/early chronic (week)
 - Intracellular methHgb
- Late chronic (weeks to months)
 - Extracellular methHgb

SIGNAL INTENSITY

- Hyperacute
 - T1 ≡; T2 inhomogeneously ↑
- Acute
 - T1 iso/mildly hypo; T2 ↓↓
- Early subacute
 - T1 ≡ center, ↑ rim
 - T2 hypointensity decreases
- Late subacute/early chronic
 - Both T1, T2
- Late chronic
 - T1 iso/hypo, T2 hyper
 - Hypointense rim

MR OF EXTREMELY HYPERACUTE ICH

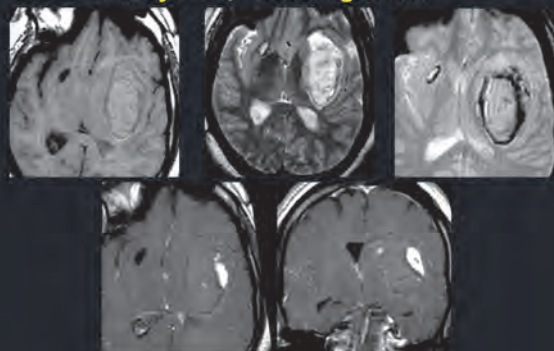
15yM With Leukemia, Scanned While Actively Bleeding

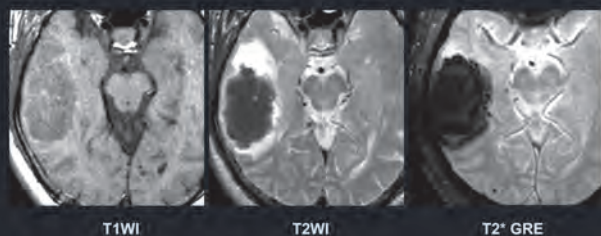
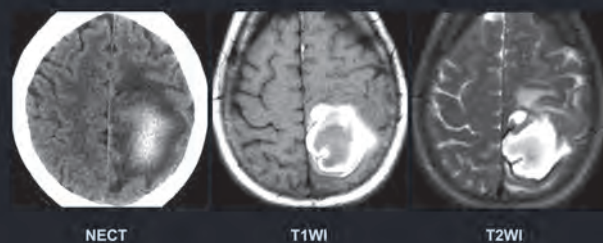
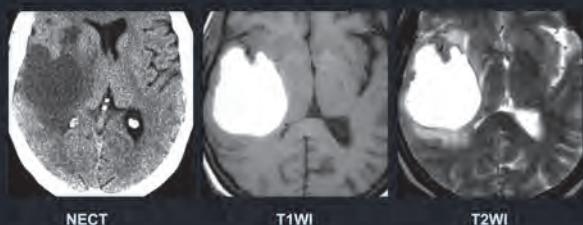
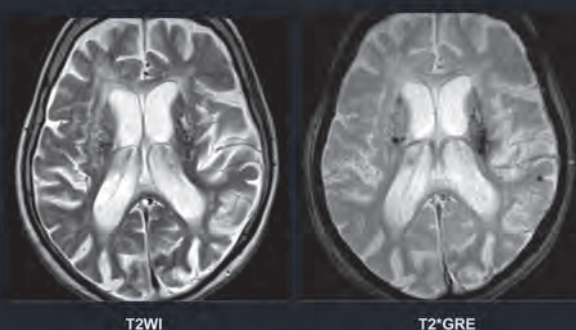


Courtesy M. Brant-Zawadzki, M.D.

MR OF HYPERACUTE ICH

Elderly HTN, "Bleeding Globe"

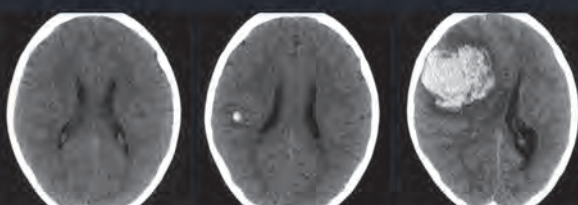
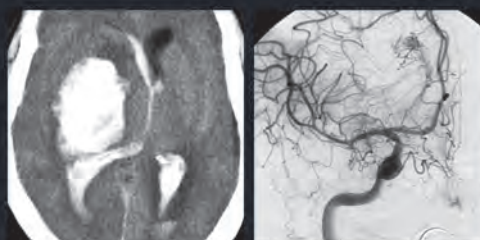


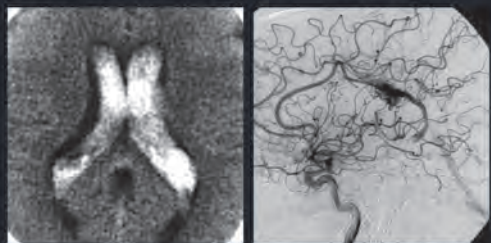
MR OF LATE ACUTE ICH**55yM with HTN, Lobar Hemorrhage, at 3 Days****MR OF EARLY SUBACUTE ICH****MR OF LATE SUBACUTE ICH****10 Days Following Hemorrhage****MR OF CHRONIC HEMORRHAGE****ETIOLOGY OF sICH****Effect of Age on DDx**

- **Child/young adult (<45y)**
 - Vascular malformation
 - Drug abuse
 - Venous occlusion/infarct
 - Vasculitis
- **Middle-aged, elderly**
 - Hypertension
 - Amyloid angiopathy
 - Primary neoplasm
 - Metastasis
 - Venous infarct
 - Vasculitis
 - Coagulopathy

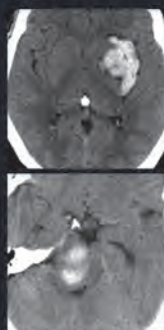
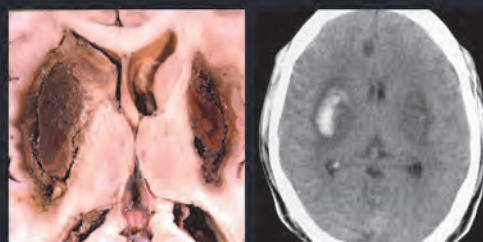
VASCULAR MALFORMATIONS

- **Child/young adult**
 - Most common cause of sICH
 - AVM, cavernous malformation
- **Middle-aged, older adults**
 - Rare
 - dAVF >> AVM
 - Draining vein thrombosis
- **Take-home lesson**
 - Spontaneous nontraumatic ICH in a child/young adult?
 - Think vascular malformation!!

**CAVERNOUS MALFORMATION****5yF With Familial CCM, Cord Lesion****AVM****46y Normotensive Male**

AVM**36yM, Sudden Severe H/A****dAVF****76yM, Normotensive****DRUG ABUSE****24y M, Cocaine O/D**

- Teenagers, young adults
 - 2nd most common cause of ICH
 - Cocaine
 - Causes extreme HTN
 - Methanol
 - Causes BG necrosis
- Take-home message
 - Unexplained ICH in young patients?
 - Do drug screen!

**26yM, Cocaine, 260/120****DRUG ABUSE****Methanol, BG Hemorrhagic Necrosis****VENOUS OCCLUSION**

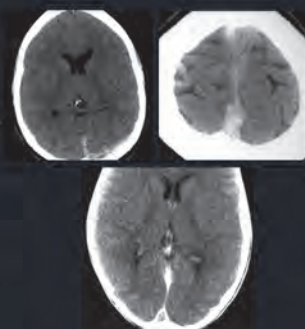
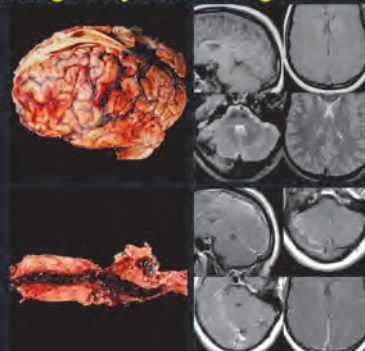
- 1% of "strokes"
- Clinical dx often difficult, elusive
 - Variable clinical presentation
 - Common: H/A, nausea, ↓ MS
- Early imaging findings often subtle
- Etiology
 - Genetic (resistance to activated protein C)
 - Trauma, infection/inflammation
 - Pregnancy, oral contraceptives
 - Metabolic (dehydration, thyrotoxicosis, etc)
 - Coagulopathy
 - Collagen-vascular, vasculitis (APLA, Behçet)

DURAL SINUS OCCLUSION: Pathology

- Dural sinus +/- cortical veins
 - SSS>TS>SS>CS
- Adjacent cortex
 - Edema
 - Early hemorrhage
- ≅ 50% progress to frank venous infarct

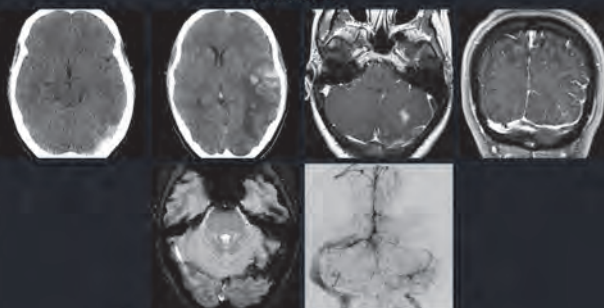
**CT OF DURAL SINUS OCCLUSION**

- NECT
 - Hyperdense dural sinus
 - Hyperdense vein ("cord sign")
 - Cortical/subcortical hemorrhage
 - Variable edema
- CECT
 - "Empty delta" sign
 - "Shaggy" falx or tentorium
 - Irregular veins

**MR OF DURAL SINUS OCCLUSION****Findings vary with clot age**

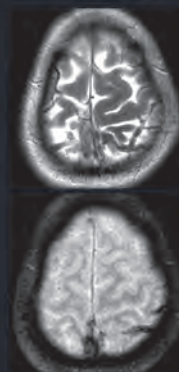
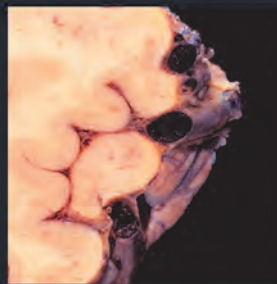
TRANSVERSE SINUS OCCLUSION

Temporal Lobe Hematoma? Think TS +/- Vein of Labbe Occlusion!



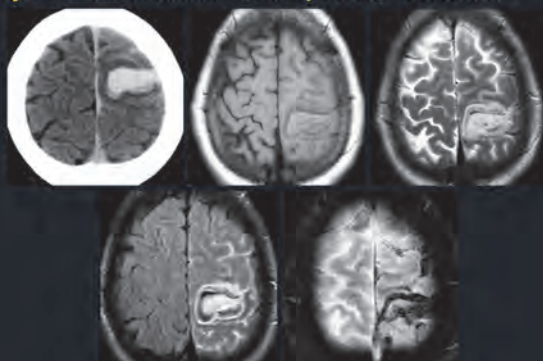
23yF, severe HA, multiple ER visits for "migraine"

CORTICAL VEIN OCCLUSION



CORTICAL VEIN THROMBOSIS

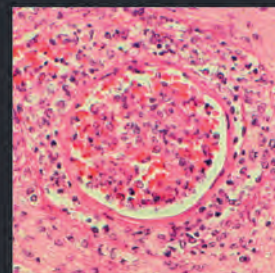
25yM in ER With Sudden R Hemiparesis, "R/O Stroke"



VASCULITIS

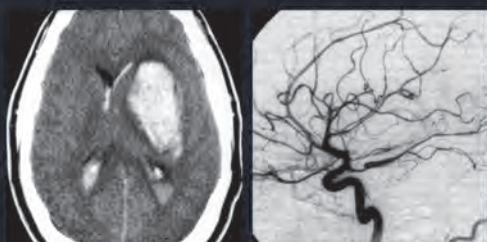
Diagnosis Requires Inflammation + Necrosis

- **Clinical/laboratory**
 - Sensitivity of biopsy 50%-75%
 - LP low sensitivity
- **Pathology**
 - Necrosis + inflammation
 - +/- post-inflammatory fibrosis
- **Imaging**
 - MR sensitivity high (85%-90%)
 - Negative study doesn't exclude
 - DSA ±
- **Vasculitis → hemorrhage?**
 - Suspect drugs, infection

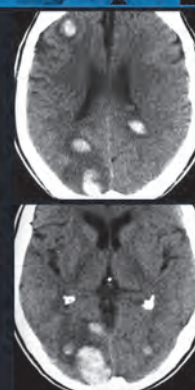


VASCULITIS

32yF, R Hemiparesis, Cocaine/Amphetamine



FUNGAL VASCULITIS



sICH

Etiology in Middle-Aged, Elderly

- Hypertension
- Amyloid angiopathy
- Primary neoplasm
- Metastasis
- Venous infarct
- Coagulopathy

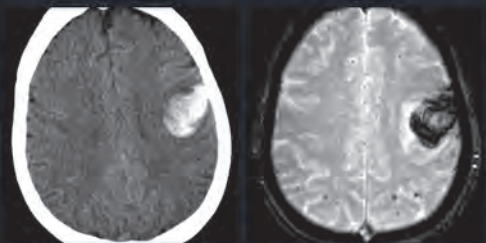
ACUTE HYPERTENSIVE HEMORRHAGE

- 10-15% of strokes
- **Hematoma location**
 - 60-65% striatocapsular
 - 15-25% thalamic
 - 10% pons, cerebellum
 - 5-10% lobar
- **Additional findings**
 - Look for "bleeding globe"
 - Look for "microbleeds"



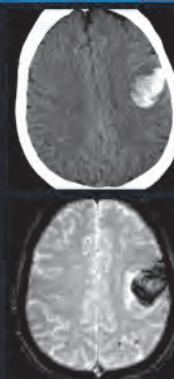
65y Male, Lobar Hemorrhage

What is Your DDx?

**DDX**

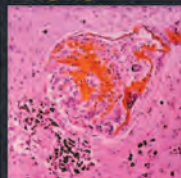
- Hypertensive bleed
 - More common than CAA
 - Microbleeds
 - Cortex
 - BG, thalami
 - Cerebellum
- CAA
- Neoplasm (met, GBM)
- Cortical vein occlusion

Hint: T2* scan should be like your favorite credit card—don't leave home without it!!

**CHRONIC HYPERTENSIVE ENCEPHALOPATHY**

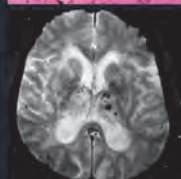
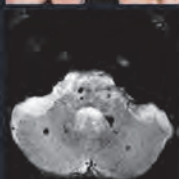
Pathology, Imaging

Striatocapsular hemorrhage



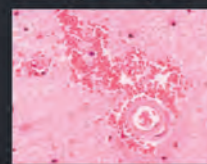
Pseudoaneurysm, microhemorrhages

BG, cerebellar microbleeds

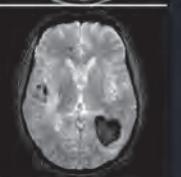
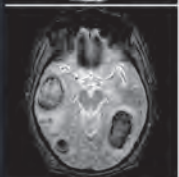
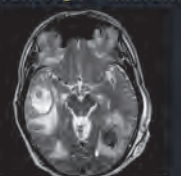
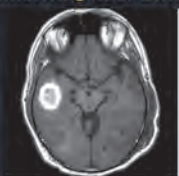
**AMYLOID ANGIOPATHY**

Epidemiology/Etiology

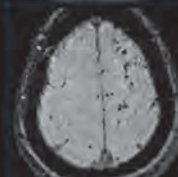
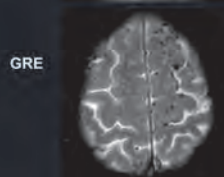
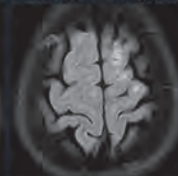
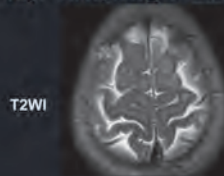
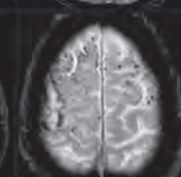
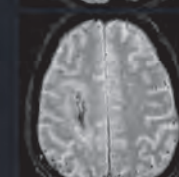
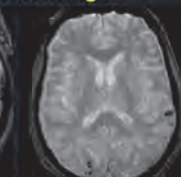
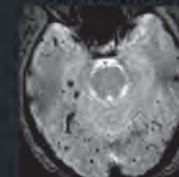
- 2nd most common cause of "spontaneous" ICH in elderly
 - 10-15%
- Aβ40 deposits in arteries/arterioles
 - Cortical, meningeal
 - Fragile, rupture
 - "Microbleeds" in PVSS
 - Lobar hemorrhages
- Imaging
 - SWI > GRE > T2 > FSET2

**AMYLOID ANGIOPATHY**

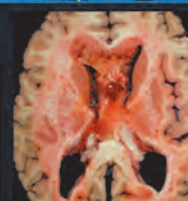
Lobar Hemorrhages of Different Age + Microhemorrhages

**AMYLOID ANGIOPATHY**

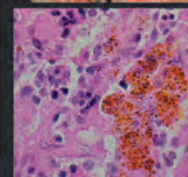
62yF TIAs, Progressive Dementia x10y, ↑"UBOs"

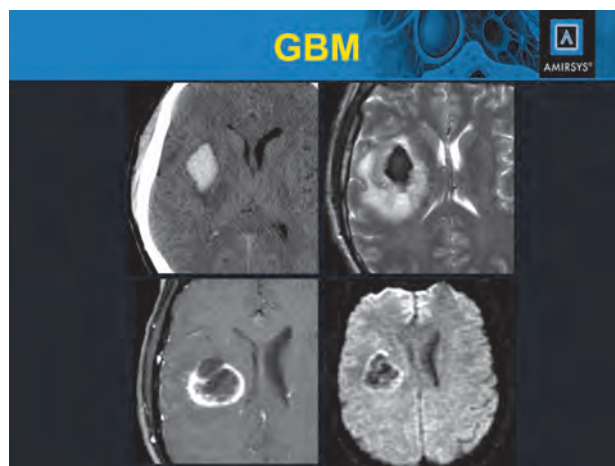
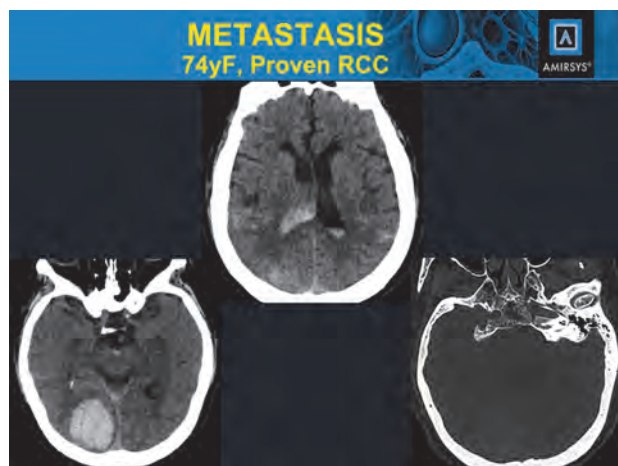
**CAA**
Elderly Demented, Normotensive Female
Hx of Lobar Hemorrhage**NEOPLASM**
(Metastasis > GBM)

Hemorrhagic Renal Mets



GBM





SUMMARY

Radiologic Reasoning: ICH

- **Child? Think vascular malformation**
- **Young adult?**
 - Vascular malformation
 - Drug abuse
 - Vein occlusion
- **Older adult?**
 - Hypertension >> everything else
 - Normotensive, demented? CAA!
 - Normotensive, normal MS, "stroke"
 - Neoplasm
 - Vein occlusion

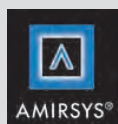
...

It was a real pleasure to be with you at the recent Radiology International Conference in St. Petersburg. During my lectures I presented images that included a lot of essential diagnostic information and differential diagnoses from STATdx. Many of you requested information about how to access this key online information. Beatty suggested I send you a brief email including information about STATdx, so here 'tis.

I always find the Radiology International experience to be rewarding and extremely beneficial in our mutual quest to keep in the forefront of medical imaging. As you know, I join you in attending all the other faculty presentations so I can learn from the experts about other body parts (yes, there is actually life outside the skull and neural foramina!). Beatty has kindly invited me to participate as part of the 2015 Northern Ireland faculty. I have been to Northern Ireland just once — and all too briefly. It was so enchanting I have longed to return for another visit. I hope to see you there. It should be a wonderful course in a spectacular location.

Best personal regards,

Anne Osborn, MD



Here is how you can learn more about Amirsys Products designed to meet the needs of Radiologists:

STATdx is the ultimate online reference system for radiologists. STATdx point-of-care diagnostic decision support system increases speed, accuracy and diagnostic confidence in complex imaging cases. STATdx streamlines workflow by reducing the time required to research and complete a difficult imaging analysis. Its online format ensures that physicians can have access to on-demand reference tools wherever and whenever needed — in the hospital, in the imaging center, or at home.

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