The Comprehensive Stroke Research Center

UAB Comprehensive STROKE CENTER

Diagnostic Techniques: an Overview of CSC Imaging Arsenal

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Disclosures

Funding: NIH-NINDS, Cerevast Therapeutics, Inc.
Editor-in-Chief, Brain and Behavior
Editorial Board
Stroke, Cerebrovasc Dis, Intl J Stroke
Director, Neurosonology Examination
American Society of Neuroimaging
Board Member
SVIN, ICAVL, ASN
Inventor, US Patent # 6733450
Chairman, Scientific Advisory Board, Cerevast Therapeutics, Inc.

Evaluation of a Stroke Patient

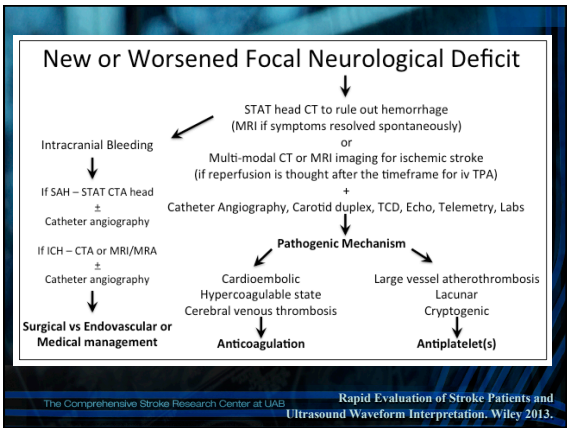
H&P Head CT ECG, blood work-up

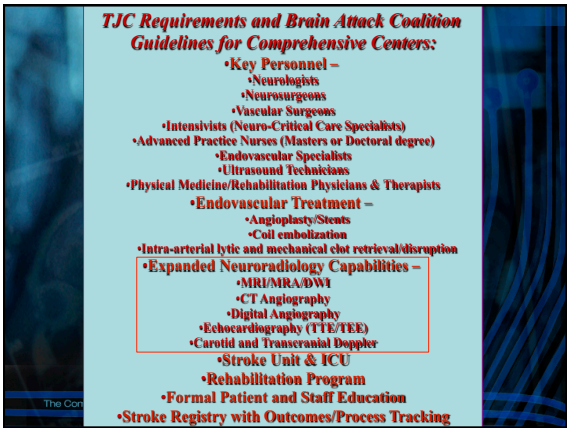
↓

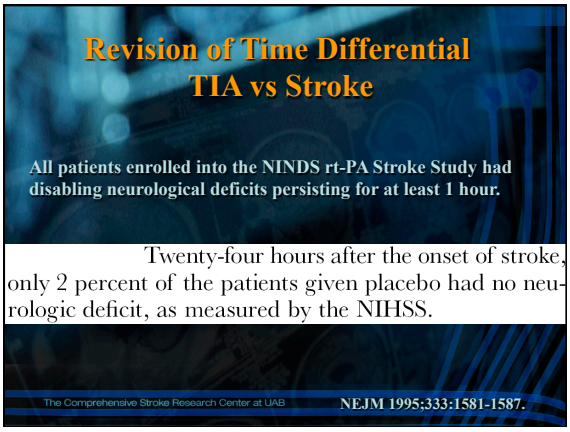
CTA, MRA, CDUS, TCD

↓

Pathogenic mechanism specific Rx
Invasive Angiography


New or Worsened Focal Neurological Deficit
STAT head CT to rule out hemorrhage
(MRI if symptoms resolved spontaneously)
or
Multi-modal CT or MRI imaging for ischemic stroke
(if reperfusion is thought after the timeframe for iv TPA)
+
Catheter Angiography, Carotid duplex, TCD, Echo, Telemetry, Labs
Intracranial Bleeding
If SAH – STAT CTA head
±
Catheter angiography
If ICH – CTA or MRI/MRA
±
Catheter angiography
Surgical vs Endovascular or
Medical management
Pathogenic Mechanism
Cardioembolic
Hypercoagulable state
Cerebral venous thrombosis
Anticoagulation
Large vessel atherothrombosis
Lacunar
Cryptogenic
Antiplatelet(s)
The Comprehensive Stroke Research Center at UAB
Rapid Evaluation of Stroke Patients and
Ultrasound Waveform Interpretation. Wiley 2013.


TJC Requirements and Brain Attack Coalition Guidelines for Comprehensive Centers:
•Key Personnel –
•Neurologists
•Neurosurgeons
•Vascular Surgeons
•Intensivists (Neuro-Critical Care Specialists)
•Advanced Practice Nurses (Masters or Doctoral degree)
•Endovascular Specialists
•Ultrasound Technicians
•Physical Medicine/Rehabilitation Physicians & Therapists
•Endovascular Treatment –
•Angioplasty/Stents
•Coil embolization
•Intra-arterial lytic and mechanical clot retrieval/disruption
•Expanded Neuroradiology Capabilities –
•MRI/MRA/DWI
•CT Angiography
•Digital Angiography
•Echocardiography (TTE/TEE)
•Carotid and Transcranial Doppler
•Stroke Unit & ICU
•Rehabilitation Program
•Formal Patient and Staff Education
•Stroke Registry with Outcomes/Process Tracking


Revision of Time Differential
TIA vs Stroke
All patients enrolled into the NINDS rt-PA Stroke Study had disabling neurological deficits persisting for at least 1 hour.
Twenty-four hours after the onset of stroke, only 2 percent of the patients given placebo had no neurologic deficit, as measured by the NIHSS.
The Comprehensive Stroke Research Center at UAB
NEJM 1995;333:1581-1587.

Definition and Evaluation of Transient Ischemic Attack

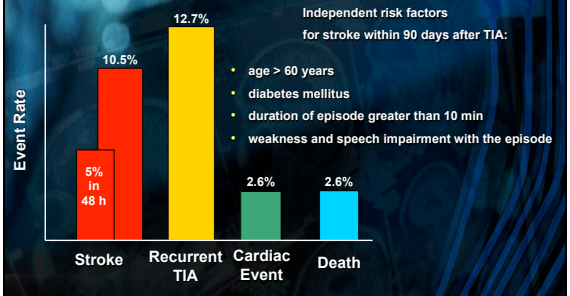
A Scientific Statement for Healthcare Professionals From the American Heart Association/American Stroke Association Stroke Council; Council on Cardiovascular Surgery and Anesthesia; Council on Cardiovascular Radiology and Intervention; Council on Cardiovascular Nursing; and the Interdisciplinary Council on Peripheral Vascular Disease

The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists.

J. Donald Easton, MD, FAHA, Chair; Jeffrey L. Saver, MD, FAHA, Vice-Chair; Gregory W. Albers, MD; Mark J. Alberts, MD, FAHA; Seemant Chaturvedi, MD, FAHA, FAAN; Edward Feldmann, MD, FAHA; Thomas S. Hatsukami, MD; Randall T. Higashida, MD, FAHA; S. Claiborne Johnston, MD, PhD; Chelsea S. Kidwell, MD, FAHA; Helmi L. Lutsep, MD; Elaine Miller, DNS, RN, CRRN, FAHA; Ralph L. Sacco, MD, MS, FAAN, FAHA

Abstract*—**This scientific statement is intended for use by physicians and allied health personnel caring for patients with transient ischemic attacks. Formal evidence review included a structured literature search of Medline from 1990 to June 2007 and data synthesis employing evidence tables, meta-analyses, and pooled analysis of individual patient-level data. The review supported endorsement of the following, tissue-based definition of transient ischemic attack (TIA): a transient episode of neurological dysfunction caused by focal brain, spinal cord, or retinal ischemia, without acute infarction. Patients with TIAs are at high risk of early stroke, and their risk may be stratified by clinical scale, vessel imaging, and diffusion magnetic resonance imaging. Diagnostic recommendations include: TIA patients should undergo neuroimaging evaluation within 24 hours of symptom onset, preferably with magnetic resonance imaging, including diffusion sequences; noninvasive imaging of the cervical vessels should be performed and noninvasive imaging of intracranial vessels is reasonable; electrocardiography should occur as soon as possible after TIA and prolonged cardiac monitoring and echocardiography are reasonable in patients in whom the vascular etiology is not yet identified; routine blood tests are reasonable; and it is reasonable to hospitalize patients with TIA if they present within 72 hours and have an $ABCD^2$ score ≥3, indicating high risk of early recurrence, or the evaluation cannot be rapidly completed on an outpatient basis. (Stroke*. 2009;40:2276-2293.)**

Event Risk Within 3 Months After TIA

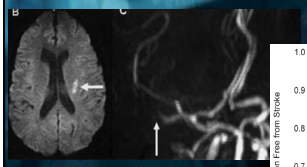


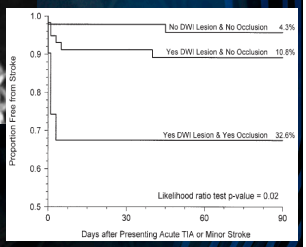
Independent risk factors for stroke within 90 days after TIA:

- age > 60 years
- diabetes mellitus
- duration of episode greater than 10 min
- weakness and speech impairment with the episode

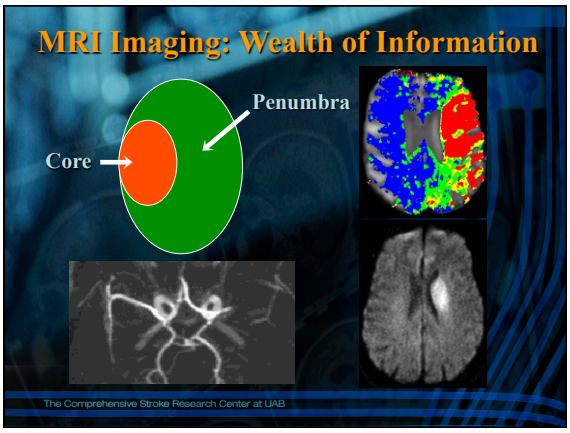
Johnston SC, et al. *JAMA*. 2000;284:2901-2906.

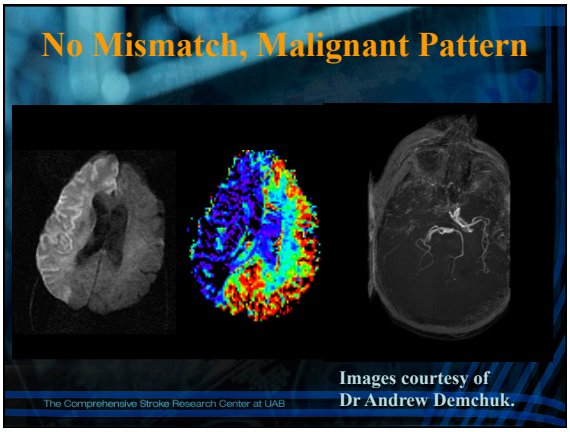
Stroke Risk after TIA

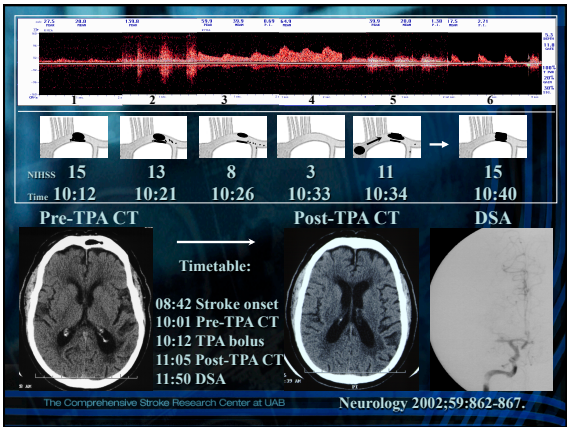




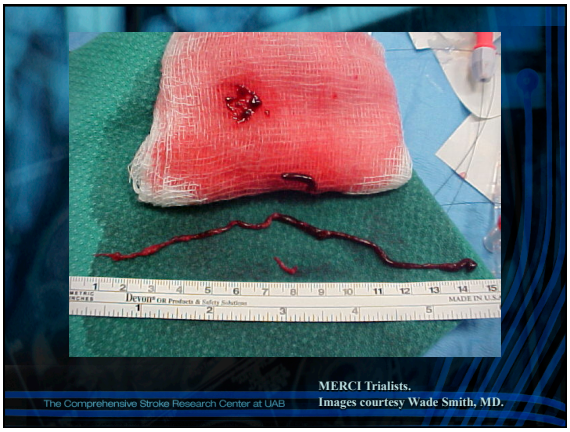
Coutts S. et al. Ann Neurol 2005;57:848-854.

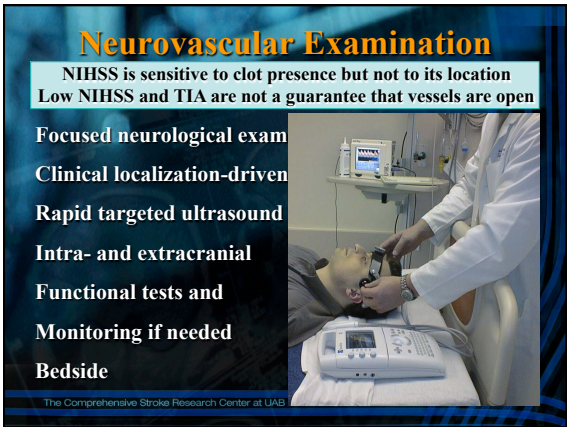

MRI Imaging: Wealth of Information
Penumbra
Core
The Comprehensive Stroke Research Center at UAB


No Mismatch, Malignant Pattern
Images courtesy of
Dr Andrew Demchuk.
The Comprehensive Stroke Research Center at UAB


1
2
3
4
5
6
NIHSS 15 13 8 3 11 15
Time 10:12 10:21 10:26 10:33 10:34 10:40
Pre-TPA CT
Post-TPA CT
DSA
Timetable:
08:42 Stroke onset
10:01 Pre-TPA CT
10:12 TPA bolus
11:05 Post-TPA CT
11:50 DSA
The Comprehensive Stroke Research Center at UAB
Neurology 2002;59:862-867.


Stentrievers:
in clinical trials
A
The Comprehensive Stroke Research


MERCI Trialists.
Images courtesy Wade Smith, MD.
The Comprehensive Stroke Research Center at UAB


Neurovascular Examination
NIHSS is sensitive to clot presence but not to its location
Low NIHSS and TIA are not a guarantee that vessels are open
Focused neurological exam
Clinical localization-driven
Rapid targeted ultrasound
Intra- and extracranial
Functional tests and
Monitoring if needed
Bedside
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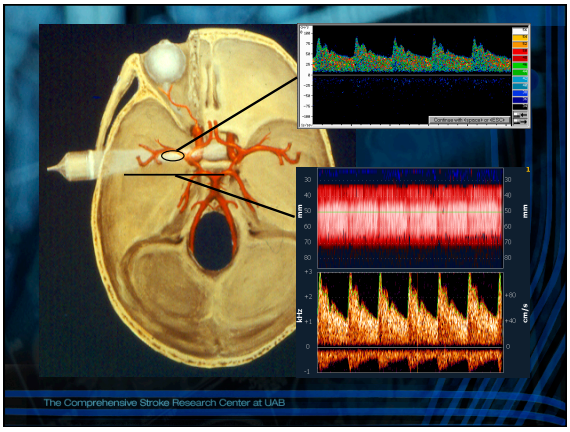

US Spectrum of Information

- Extracranial lesion localization/stenosis grading
- Downstream hemodynamic changes: collaterals
- Emboli detection: localization and quantification
- Right-to-left shunt testing
- Intracranial stenoses
- Vasomotor reactivity
- Recanalization, reocclusion, hypo- & hyperperfusion
- Vasospasm detection, grading and monitoring
- Arterial steals

Neurovascular Examination
Rapid Evaluation of Stroke Patients and Ultrasound Waveform Interpretation. Wiley (in press).

Practice Standards for Transcranial Doppler Ultrasound: Part I—Test Performance

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Michael A. Sloan, MD
Lawrence K.S. Wong, MD
Colleen Douville, RVT
Alexander Y. Razumovsky, PhD
Walter J. Koroshetz, MD
Manfred Kaps, MD
Charles H. Tegeler, MD
for the American Society of Neuroimaging Practice Guidelines Committee

J Neuroimaging 2007;17:11-18.

Clinical Applications of TCD: Type, Strength of Evidence

1.	Sickle Cell Anemia	A, I-II
2.	Subarachnoid Hemorrhage	A, I-II
3.	Ischemic Stroke/TIA	
	1. Intracranial stenosis-occlusion	B, II-III
	2. Vasomotor reactivity testing	B, II-III
	3. Monitoring thrombolysis	B, II-III
4.	Cerebral circulatory arrest	A, II
5.	Detection of right-left shunts	A, II
6.	Monitoring CEA / CABG	B, II-III/B-C, II-III
7.	Headache, Venous Thrombosis	Doubtful

Sloan M, et al. Neurology 2004;62:1468-81.
Babikian VL, et al. J Neuroimaging 2000;10:101-115.

Practice Standards for Transcranial Doppler (TCD) Ultrasound. Part II. Clinical Indications and Expected Outcomes

Andrei V. Alexandrov, Michael A. Sloan, Charles H. Tegeler, David N. Newell, Alan Lumsden, Zsolt Garami, Christopher R. Levy, Lawrence K.S. Wong, Colleen Douville, Manfred Kaps, Georgios Tsivgoulis; for the American Society of Neuroimaging Practice Guidelines Committee

From the Comprehensive Stroke Center, University of Alabama at Birmingham, Birmingham, AL (AVA, GT); Comprehensive Stroke Center, University of South Florida, Tampa, FL (MAS); Stroke Program, Wake Forest University Medical Center, Winston-Salem, NC (CHT); Department of Neurosurgery, Swedish Hospital, Seattle, WA (DNN, CD); Department of Cardio-Thoracic Surgery, Cornell University and The Methodist Hospital Houston, TX (AL, ZG); Hunter Stroke Service, Hunter New England Area Health Service, New South Wales, Australia (CRL); Division of Neurology, Chinese University of Hong Kong, Hong Kong, China (LKSW); Department of Neurology, University of Giessen, Giessen, Germany (MK); Department of Neurology, Democritus University of Thrace, Alexandroupolis, Greece (GT).

ABSTRACT

Transcranial Doppler (TCD) is a physiological ultrasound test with established safety and efficacy. Although imaging devices may be used to depict intracranial flow superimposed on structural visualization, the end-result provided by imaging duplex or nonimaging TCD is sampling physiological flow variables through the spectral waveform assessment. Clinical indications considered by this multidisciplinary panel of experts as established are: sickle-cell-disease, cerebral ischemia, detection of right-to-left shunts (RLS), subarachnoid hemorrhage, brain death, and periprocedural or surgical monitoring. The following TCD-procedures are performed in routine in- and outpatient clinical practice: complete or partial TCD-examination to detect normal, stenosed, or occluded intracranial vessels, collaterals to locate an arterial obstruction and refine carotid-duplex or noninvasive angiographic findings; vasomotor-reactivity testing to identify high-risk patients for first-ever or recurrent stroke; emboli detection to detect, localize, and quantify cerebral embolization in real time; RLS-detection in patients with suspected paradoxical embolism or those considered for shunt closure; monitoring of thrombolysis to facilitate recanalization and detect reocclusion; monitoring of endovascular stenting, carotid endarterectomy, and cardiac-surgery to detect perioperative embolism, thrombosis, hypo- and hyperperfusion. By defining the scope of practice, these standards will assist referring and reporting physicians and third parties involved in the process of requesting, evaluating, and acting upon TCD results.

Keywords: TCD, indications, applications and outcomes.

Acceptance: Received May 23, 2010, and in revised form July 06, 2010. Accepted for publication July 15, 2010.

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J Neuroimaging 2010;XX:1-10.
DOI: 10.1111/j.1552-6569.2010.00523.x

A 16 year old girl had a sudden onset of left sided weakness. Normal CT scan done at 2.5 hr. TPA given at 3 hours, transferred to a level 1 hospital, and improvement noted en route.

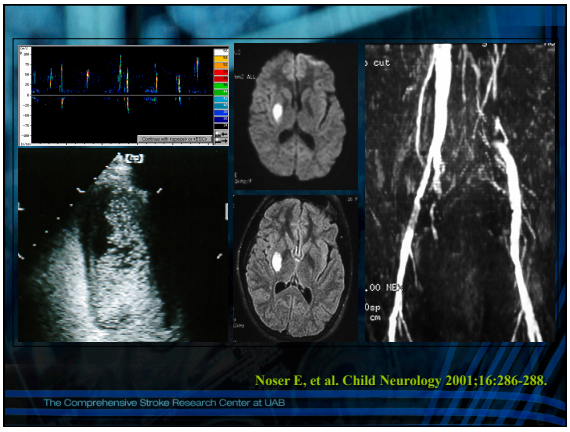
Risk factors: smoking, birth-control pill

NIHSS 4 points upon arrival

Dx: ?

Prognosis: ?

Noser E, et al. Child Neurology 2001;16:286-288.


Noser E, et al. Child Neurology 2001;16:286-288.
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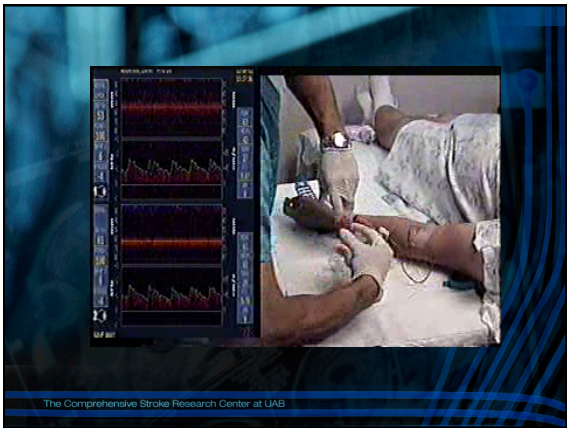
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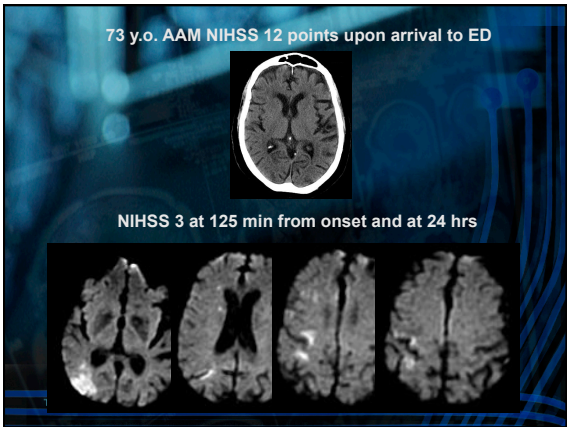
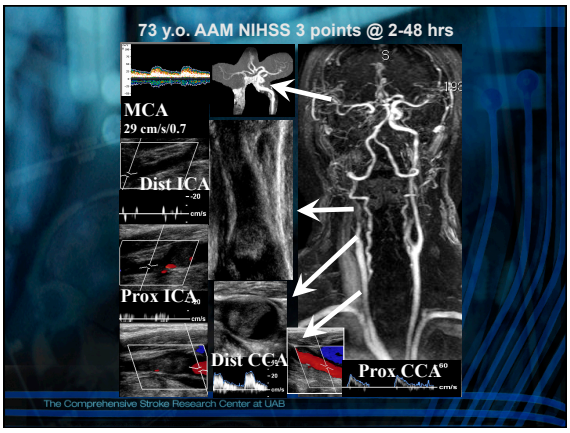

73 y.o. AAM NIHSS 12 points upon arrival to ED
NIHSS 3 at 125 min from onset and at 24 hrs


73 y.o. AAM NIHSS 3 points @ 2-48 hrs
MCA
29 cm/s/0.7
Dist ICA
Prox ICA
Dist CCA
Prox CCA
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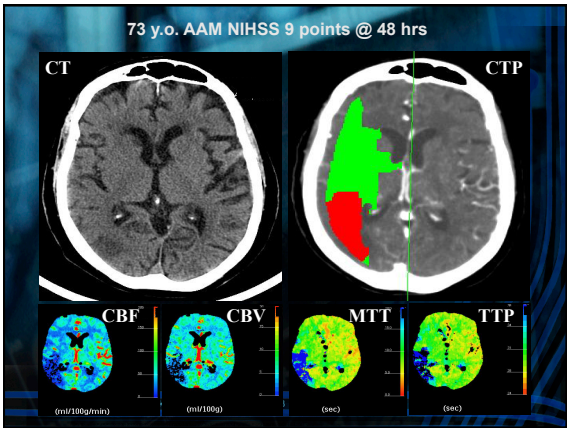
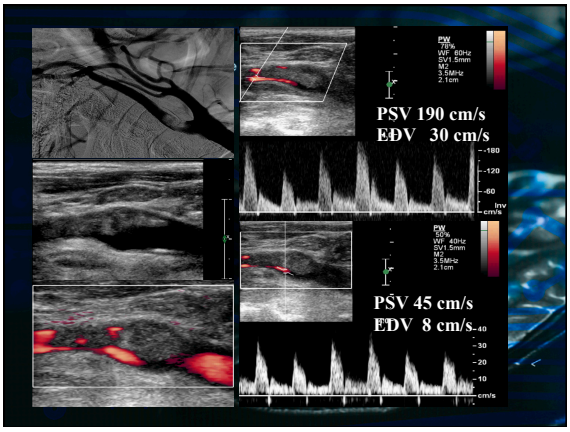
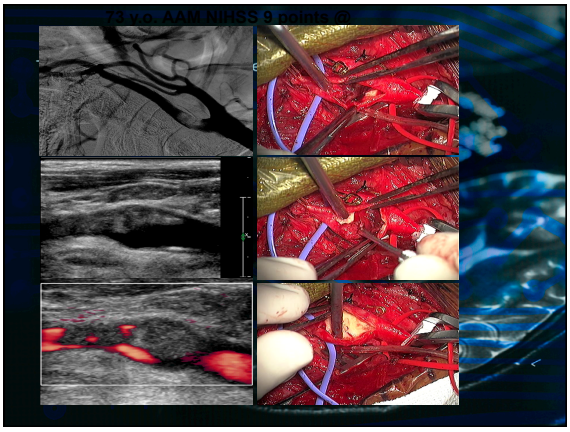
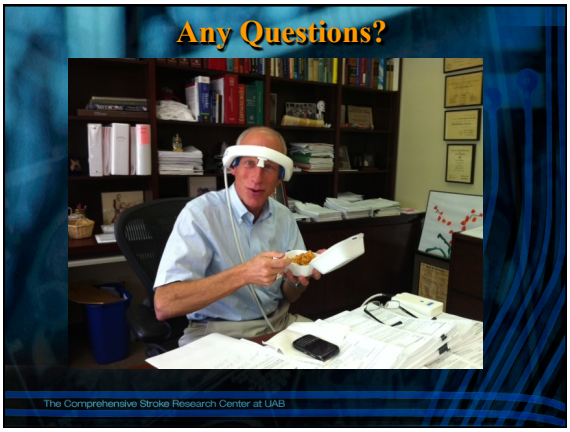

73 y.o. AAM NIHSS 9 points @ 48 hrs
CT
CTP
CBF
CBV
MTT
TTP
(ml/100g/min)
(ml/100g)
(sec)
(sec)


PSV 190 cm/s
EDV 30 cm/s
PSV 45 cm/s
EDV 8 cm/s


73 y.o. AAM NIHSS 9 points @


Any Questions?
The Comprehensive Stroke Research Center at UAB